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Worldwide Report

NUCLEAR DEVELOPMENT AND PROLIFERATION

No. 179

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STA TO BUILD URANIUM ENRICHMENT PLANT MID 1983

Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 23 Sep 82 p 8

[Text] The Science and Technology Agency [STA] aims to start construction in mid-1983 of a uranimm enrichment prototype plant (with a capacity of 200 tons SWU [separative work unit] per year). This plant is scheduled for construction in two phases: the initial phase (100 tons SWU per year, starting operation in FY 86). The total construction cost will be 66 to 67 billion yen. Of this amount, the STA has requested approximately 1.06 billion yen in next fiscal year's budget, and the private share will be 1.06 billion yen in the next fiscal year, so together they will spend 2.12 billion yen. The intention is to start site preparation and appurtenant work, and thereby open a new phase in the plan to enrich uranium in Japan.

The amount of uranium enrichment needed in Japan's plan to generate nuclear energy is expected to reach about 8,000 tons SWU per year in 1990, and about 12,000 tons SWU per year in the year 2000.

As far as supply vs. demand is concerned, the enrichment needed until 1990 is already guaranteed by the long-term contracts of the electric power companies. However, the supply-demand balance is expected to disintegrate after that, and it is expected that from that fiscal year balance, an insufficiency of about 7,000 tons SWU per year will occur around the year 2000.

In this situation, the Atomic Energy Commission's new long-term plan for promoting the development of uranium enrichment says, "In order to guarantee the stable supply of enriched uranium, and actively promote domestic production of it, it is necessary to immediately start construction of a prototype plant, bearing in mind the experience of the Ningyotoge pilot plant."

In response to this policy, the STA hurried to select a location for the prototype plant, and based on that progress, aims to start construction the middle of next year.

The prototype plant will produce 200 tons SWU per year, and the total construction cost is estimated at 66 to 67 billion yen.

With regard to the apportionment, the Power Reactor and Nuclear Fuel Development Corporation will borrow 25 percent from commercial banks, and the government and private sectors will split the remaining 75 percent (37.5 percent each). This is based on the judgement that the 25 percent the Power Reactor and Nuclear Fuel Development Corporation will borrow from commercial banks can be repaid by operating income obtained by future operation of the model plant.

The STA has already requested about 1.06 billion yen in its budget for the next fiscal year, and, with a private portion of another 1.06 billion yen, it will invest 2.12 billion yen, and start construction.

In addition to investing 0.9 billion yen in site preparation, the STA plans to use the remaining 1.2 billion yen to carry out water line construction and feeder road and high-tension wire construction;.

As far as the location is concerned, a basic survey is being carried out in Okayama prefecture at the local governments invitation. So far Kami Saibara-Mura, Kume Machi, and Shoboku Cho have emerged as candidates, but the STA plans to decide whether to proceed with the next stage of the survey, based on the results of the first survey which are to be announced shortly.

The construction is scheduled to be carried out in two sections, each producing 100 tons SWU per year. The first phase is expected to start operation in FY 85, and the second phase in FY 86.

9991
CSO: 5100/4206

REPAIRS, REDUCED OUTPUT OF NUCLEAR PLANT NOTED

PY222027 Buenos Aires DYN in Spanish 2315 GMT 21 Jan 83

[Excerpt] Buenos Aires, 21 Jan (DYN) -- Energy Secretary Alieto Guadagni confirmed today that the Atucha nuclear plant has been virtually at a standstill not only for the past 3 months but since the second half of 1982. Guadagni attributed this situation to maintenance work at the plant and to the rains that have affected the entire country since the end of June 1982.

During an impromptu press conference, Guadagni stated that the rains, a situation which he described as "highly favorable for hydroelectric energy production," prompted the decision to order "the reduction of the Atucha plant's output" at the beginning of July. For this reason, the National Atomic Energy Commission decided to begin with the scheduled maintenance work and to stop the plant on 21 July.

The maintenance work was scheduled to conclude on 9 August. However the plant could not start operating again until 22 November because of major damage. The plant is delivering "a reduced amount of energy" to the interconnected system because the hydroelectric plants are able to handle all the needs.

CSO: 5100/2029

BRAZIL REACTS TO REPORT ON PLUTONIUM PRODUCTION

Official Statement Released

PY052222 Sao Paulo O ESTADO DE SAO PAULO in Portuguese 5 Feb 83 p 6

["Text" of note issued by the Brazilian Foreign Ministry in Brasilia on 4 February]

[Text] With reference to an article published by a U.S. newspaper yesterday and reproduced by the Brazilian media today regarding the Brazilian Nuclear and Energy Research Institute (IPEN) the Foreign Relations Ministry hereby informs that:

1. IPEN's U.S.-supplied reactor is subject to the International Atomic Energy Agency (IAEA) safeguard clauses, which are contained in the safeguard agreement signed between Brazil, the United States and the IAEA.

2. What the article has reported as being IPEN's reprocessing unit in reality is a laboratory for evaluating the safety of nuclear material. Its purpose is to train technicians in nuclear safety.

3. The laboratory has not handled any type of radioactive material. Should it do so, all of Brazil's international commitments regarding nuclear safeguards will be strictly complied with.

4. The Brazilian Government has and will always continue to comply with the commitments undertaken in the international agreements regarding cooperation in the use of nuclear energy for peaceful purposes, including the agreement signed with the United States and the corresponding agreement establishing safeguards signed by Brazil, the United States and the IAEA.

5. The Brazilian Government reasserts the exclusively peaceful purposes of its nuclear program, which is aimed at meeting the country's technological and socioeconomic development needs.

Spokesman Calls Treaty 'Unfair'

PY051856 Sao Paulo Radio Bandeirantes Network in Portuguese 1000 GMT 5 Feb 83

[Text] In Brasilia, Itamaraty spokesman Bernardo Pericas made it clear that Brazil will not alter its nuclear policy. Pericas said that he considers the nuclear arms nonproliferation treaty unfair.

Pericas said that the Brazilian Government reasserts the exclusively peaceful purposes of its nuclear program, which is aimed at meeting the country's technical, economic and social development needs.

Plutonium 'Not for Military Purposes'

PY050007 Porto Alegre Radio Guaiba in Portuguese 2150 GMT 4 Feb 83

[Text] Before returning to Brasilia, Mines and Energy Minister Cesar Cals told reporters that Brazil will have to produce plutonium, but not for military purposes.

Minister Cals explained that the contracts for nuclear technology transfer that Brazil has signed foresee the reprocessing of several products. One of those products will be plutonium, which will be used in fast reactors.

Report on IPEN Reactor

PY050240 Rio de Janeiro JORNAL DO BRASIL in Portuguese 4 Feb 83 p 8

[Text] Sao Paulo -- During its 26 years of existence the small research reactor of the Nuclear and Energy Research Institute (IPEN) has been operating for an average of 40 hours a week. On this operating basis it would be necessary to irradiate some 100 kilos of natural uranium for 120 years in order to produce 700 grams of plutonium.

The IPEN reactor operates with uranium enriched to a 93.17 percent and the remaining 7 percent with 238 uranium (atomic waste) which contains a small amount of plutonium. Therefore, more than a century would be necessary to accumulate a reasonable quantity of this element and "the little bit which has been gathered so far by the IPEN has been shipped to the United States," states scientist Roberto Hukay.

Hukay, who was area manager of the IPEN and now holds the post of coordinator of nuclear affairs of the Sao Paulo Industry, Commerce, Science and Technology Secretariat, after calculating how long it would take to produce plutonium points out that the entire operation of the IEA-RL [IEA - Atomic Energy Institute; RL - expansion unknown] reactor is supervised by the International Atomic Energy Agency [IAEA]. Furthermore, even if the plutonium existed, it could not be reprocessed at this time because "the IPEN is still working on the project for an experimental reprocessing unit which will be completed only in the next few years."

The only Brazilian nuclear program which could be converted for military use is not part of the Brazilian-FRG agreement. That potential-military program involves alternatives based on the utilization of a uranium enrichment process through ultracentrifugation, inasmuch as the jet nozzle [given in English] enrichment process, which the FRG is transferring to Brazil, has not yet been commercially approved.

Work on such alternatives began in 1978. The Brazilian nuclear program underwent a fission of its own: The generation of electricity by nuclear means was assigned to Nuclebras, and the work on uranium enrichment -- which falls under national security requirements and contemplates the future manufacture of weapons -- was assigned to the IPEN.

The uraniun enrichment is labeled secret. Studies have advanced past the preliminary phase which consist in the design of the main parts for the ultracentrifugation equipment. The Sao Jose dos Campos CTA [Aerospace Technological Center] is testing the rotor of the ultracentrifuge in a high pressure chamber. The IPT [Technological Research Institute] is working on microelectronic components for the project.

This project, which is to be completed early inthe 1990's, will cost $100 million. It will be apportioned 12 billion cruzeiros in 1983.

CSO: 5100/2036

NUCLEBRAS HEAD TO BE REPLACED IN FEBRUARY: REASONS CITED

Batista's 'Delicate Situation'

Sao Paulo O ESTADO DE SAO PAULO in Portuguese 23 Jan 83 p 51

[Text] Ambassador Paulo Nogueira Batista should be leaving the presidency of NUCLEBRAS [Brazilian Nuclear Corporations] in February, when his mandate and that of the other directors of the corporation ends, a highly qualified source in the Ministry of Mines and Energy admitted yesterday.

Batista has been in a "delicate situation" since he decided to award contracts, without competitive bidding, to businessmen Camargo Correa and Mendes Junior to build the infrastructures for the Iguape I and II nuclear plants on the southern coast of Sao Paulo, the same source observed. The situation of the current president of NUCLEBRAS worsened following the cuts that severely affected the Brazilian nuclear program, entailing immediate suspension of construction of the two plants and delay in the initiation of operations at Angra II and III, in the city of Angra dos Reis on the coast of Rio de Janeiro State.

It was also confirmed that Proenca Rosa, current chief of the economic department of Itamatary, has been chosen to replace Nogueira Batista. According to the source, the reason one diplomat is being succeeded by another as president of NUCLEBRAS is that the government needs an individual with experience and qualifications in the international area for a round of negotiations with the FRG Government regarding the German-Brazilian nuclear accord. Although the general lines of the accord need no revision, the fact is that the change in the schedule and in the emphasis on nuclear program will require negotiations with the country which has promised to provide the technology to Brazil to develop its nuclear program.

The fall of Nogueira Batista will be another victory for Minister of Mines and Energy Cesar Cals; from the time Cals assumed the ministry, he has not concealed his displeasure with the nuclear program formulated during the term of his predecessor, Shigeaki Ueki, currently president of PETROBRAS [Brazilian Petroleum Corporation].

Solicitation of Bids

When the federal government decides to initiate civil construction for the Iguape I and II nuclear plants on the Sao Paulo coast, NUCLEBRAS must publicly solicit bids by construction companies to build the two plants, thus nullifying the contracts awarded to Mendes Junior and Camargo Correa by the NUCON Administrative Council in its meeting of 15 December. No date has been scheduled for initiation of construction, nor will it be scheduled as long as the current economic recession continues.

The information was offered yesterday by an important advisor of the Ministry of Mines and Energy. He admitted at that time that one of the main reasons for the rumors of the imminent dismissal of NUCLEBRAS president Nogueira was the way in which NUCON selected the two construction companies to handle the civil construction and infrastructures for Iguape I and II.

Nogueira's dismissal involved Iguape nuclear plants

Dismissal Imminent

Sao Paulo O ESTADO DE SAO PAULO 22 Jan 83 p 23

[Text] The dismissal of NUCLEBRAS president Paulo Nogueira Batista is imminent, according to rumors circulating more insistently yesterday in Brasilia. The individual mentioned most as his replacement--and who could receive the appointment, according to specialists in the energy sector--is Proenca Rosa, chief of the economic department of Itamaraty, a diplomat who took part in all the negotiations for the signing of the Brazilian-FRG nuclear accord in 1975. Technicians in the Ministry of Mines and Energy confirmed that NUCLEBRAS director John Formann, responsible for the superintendencies of Poco de Caldas and Mineral Engineering, had submitted his letter of resignation to Nogueira, claiming that he had been with the enterprise since its creation in 1974 and was tired. It is rumored, however, that Formann submitted his resignation because he does not agree with positions of the NUCLEBRAS administration.

NUCLEBRAS press advisor Cesarion Praxedes said over the telephone that "this is an inaccurate rumor about the dismissal of Doctor Paulo. They are irresponsible speculations, because either the fellow has the information and reports it to the press or he does not talk about it. We are in a period of liberalization, with a free press, and people can speak out openly."

Regarding Formann's resignation, Praxedes said that "the truth is something else. This rumor has been going around since November and there has been no letter of resignation, but it is said that [Formann] does not wish to renew his mandate, which ends in March."

Causes

The main reason for the probable dismissal of Paulo Nogueira may be President Joao Figueiredo's irritation at the awarding of contracts, without public bidding, to builders Camargo Correa and Mendes Junior for civil construction and the infrastructures of Iguape I and II nuclear plants. Initiation of civil construction was indefinitely suspended by the president of the republic, claiming a shortage of funds.

President Figueiredo may also be irritated by Batista's insistence in wishing to go to the FRG to explain the reasons for the new delay in carrying out the FRG-Brazilian nuclear agreement providing for construction of eight plants, since the scheduled date for the operation of Angra I and III has been posponed for more than a year and the initiation of construction of Iguape I and II has been put off. The government considers this trip entirely unnecessary.

Sources in the energy sector have also reported that the dismissal of the NUCLEBRAS president is also dependent on the investigation by the SNI [National Intelligence Service] regarding the public competition in which builder Andrade Gutierrez was awarded the contract for civil construction of Angra III and Mendes Junior and Camargo Correa were chosen for the Iguape I and II construction works.

The same sources observed that an announcement by NUCON, a subsidiary of NUCLEBRAS, regarding the competition appeared in the newspapers on 15 December 1981. The announcement raised doubts as to the good faith of the award of contracts to the two construction firms for the works at Iguape I and II. On that occasion, Cesar Cals himself, minister of mines and engineering, justifying the postponement of these two projects, said they were not planned for this year but that the NUCON administration recommended that NUCLEBRAS initiate them in 1983.

The announcement to which the sources referred is a report on the meeting of the NUCON Administrative Council on 15 December 1982, stating that, in the competitive bidding for civil construction at Angra III, three firms were rated in descending order: Andrade Gutierrez, Mendes Junior and Camargo Correa. In Item 3 of the report, entitled "Civil Construction for Iguape I and II," the NUCOM Administrative Council "advises the executive directorate to invite the firms rated second and third to negotiate, as a consortium, contracts to carry out the civil construction for Iguape I and II, including the respective infrastructures."

6362
CSO: 5100/2030

URANIUM RESOURCES ADEQUATE FOR NUCLEAR POWER PROGRAM

New Delhi PATRIOT in English 7 Jan 83 p 2

[Text] THE two organisations, Atomic Minerals' Division (AMD) and Uranium Corporation of India (UCIL), working in close cooperation have now established that India has adequate resources of uranium to meet the country's requirements for its nuclear power programme, it is authoritatively learnt.

Alongwith this the identified and reasonably assured estimated additional resources stand at 67,000 tonnes of uranium besides some 13,000 tonnes of uranium contained in the monozite sands occurring along the beaches and inland places deposits. India's thorium resources are estimated at 363,000 tonnes of fissile isotope of thorium.

While all the major vein or disseminated type uranium deposits are located in the pre-Cambrian metamorphic complexes in Singhbhum Thrust Belt of Bihar and a few smaller ones in Rajasthan, exploration and prospecting carried out during recent years have brought to light several new uranium provinces in various parts of India, the most significant ones being at Bodal and Jojawal in Rajnandgaon and Sarguja districts respectively of Madhya Pradesh and in some parts of Himachal Pradesh and Uttar Pradesh.

Among the sedimentary type deposits, the extensive conglomerates in northern Karnataka, the cretaceous sandstones in parts of Meghalaya and tertiary sandstones in Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh have shown noteworthy uranium bearing horizons, some of which are currently under intensive investigation by exploratory drilling and/or underground development.

Uranium in significant tonnage also occurs associated with large exploitable deposits of cooper in Singhbhum Thrust Belt of Bihar and some phosphate deposits in Uttar Pradesh.

Atomic Minerals Division's (AMD) exploration activities are dovetailed with those of Uranium Corporation of India Ltd (UCIL); the company takes over from the AMD after an uranium deposit has been explored, prospected and evaluated by the latter and undertakes commercial mining and production of yellow cake.

UCIL has plans to expand and operate two more deposits at Narwapahar and Turamdih which are located in the same mineralised belt known as Singhbhum Thrust Belt, under similar geological setting. Feasibility studies for opening up of the deposits have been completed and detailed development designs are under formulation. Experience gained in operating the mine and the mill at Jaduguda will be utilised to design improved layout and reduce the leadtime between mining and milling.

UCIL will open yet another deposit at Bodal in Madhya Pradesh to meet the increased requirement of uranium for India's nuclear power programme.

In the copper mines of the Singhbhum Thrust Belt, uranium in small percentages occurs in association with copper lodes. Sufficient know-how has been developed for recovery of uranium as a by-product of copper. After establishing the economic feasibility for its recovery a uranium plant has been set up adjacent to the copper mine. It is proposed to set up similar plants at other copper mines.

CSO: 5100/7050

STATUS OF ARRANGEMENTS FOR FRENCH FUEL EXAMINED

Bombay THE TIMES OF INDIA in English 27 Dec 82 p 1

[Text] London, December 26 (PTI).

France will begin supply of enriched uranium for the Tarapur atomic power plant shortly, possibly by April next.

The schedule of deliveries and other commercial aspects of the Franco-Indian agreement reached in New Delhi last month, are being worked out by a French team which is having talks in Bombay with the Atomic Energy Commission.

A spokesman for the Indian embassy in Paris said that there was no problem in regard to the commencement of the supplies. These would begin shortly after the commercial aspects had been finalised.

According to French sources about 20 tonnes of enriched uranium are likely to be supplied annually for Tarapur.

The French sources also indicated that supplies would begin shortly. However, the two countries would later have to decide through mutual consultations on arrangements for the use of spent fuel after the expiry of the Indo-U.S. agreement under which France is making the supplies, they said.

No New Contract

France is understood to have explained to EEC and fellow members of the London club of nuclear suppliers that its agreement with India did not constitute a new contract since it was merely stepping in to replace the U.S. which had a 30-year-agreement with India.

This follows reported objections by the European commission which considers the Indo-French agreement to be in disregard of EEC rules. The EEC members are guided by Eurcom treaty on uranium trade and commission official had complained that France had not asked for EEC approval before reaching an agreement with India.

Meanwhile, as a follow up of the discussions held during President Mitterand's visit to India last month, India and France are working out arrangements for the establishment of an Indo-French centre for advanced research in India, most likely in New Delhi.

Dr. S. Vardarajan, secretary, department of science and technology, and the Indian ambassador to France, Mr. Narendra Singh, held discussions in this connection with French minister for scientific research and other officials.

According to the Indian embassy spokesman, the centre is likely to be established within three months. It would have French and Indian governors and will be financed jointly by the two governments.

The Centre is to promote exchange of scientists and research in India on renewable energy, bio technology and other sciences.

Meanwhile, Japan has pledged to strengthen the base of its nuclear industry so that it would be ready to export nuclear power plants in future.

The Japanese Atomic Energy Commission (JAEC) has offered massive support and encouragement to its private companies to lay the groundwork for nuclear exports.

JAEC has asked the nuclear power equipment makers to ready themselves for export of nuclear power plants by developing their own technology and by studying financial measures.

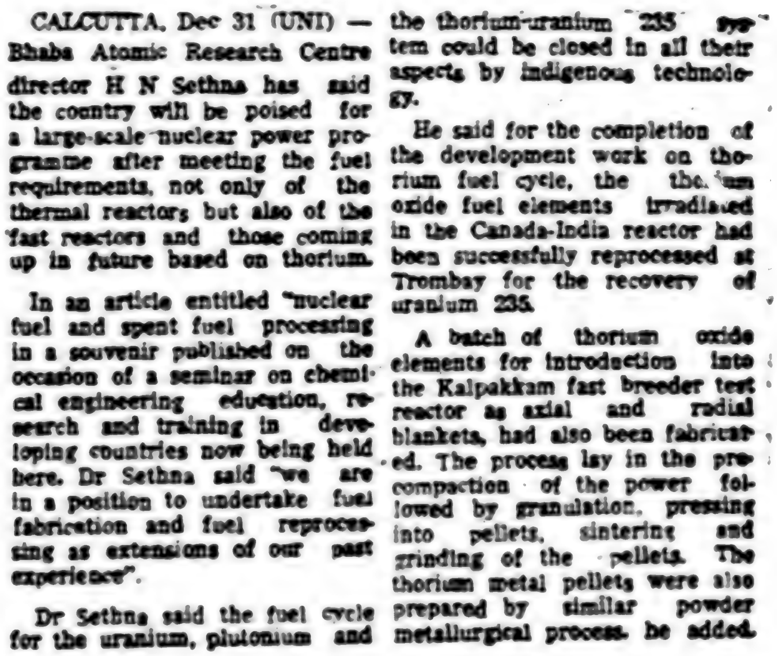
According to JAEC, the transfer of nuclear materials and technology to other countries "is expected to become increasingly active," and the demand of developing countries for Japan's nuclear fuel service "is likely to grow in the coming years."

CSO: 5100/7015

SETHNA: INDIA POISED FOR BIG NUCLEAR POWER PROGRAM

New Delhi PATRIOT in English 1 Jan 83 p 2

[Text]



CALCUTTA, Dec 31 (UNI) — Bhaba Atomic Research Centre director H N Sethna has said the country will be poised for a large-scale nuclear power programme after meeting the fuel requirements, not only of the thermal reactors but also of the fast reactors and those coming up in future based on thorium.

In an article entitled "nuclear fuel and spent fuel processing in a souvenir published on the occasion of a seminar on chemical engineering education, research and training in developing countries now being held here. Dr Sethna said "we are in a position to undertake fuel fabrication and fuel reprocessing as extensions of our past experience".

Dr Sethna said the fuel cycle for the uranium, plutonium and the thorium-uranium 235 system could be closed in all their aspects by indigenous technology.

He said for the completion of the development work on thorium fuel cycle, the thorium oxide fuel elements irradiated in the Canada-India reactor had been successfully reprocessed at Trombay for the recovery of uranium 235.

A batch of thorium oxide elements for introduction into the Kalpakkam fast breeder test reactor as axial and radial blankets, had also been fabricated. The process lay in the pre-compaction of the power followed by granulation, pressing into pellets, sintering and grinding of the pellets. The thorium metal pellets were also prepared by similar powder metallurgical process, he added.

CSO: 5100/7049

BRIEFS

NUCLEAR ENERGY PROSPECTS--BOMBAY, Jan. 12--The dream of fusion reactors will be achieved during the first half of the next century, the Atomic Energy Commission Chairman, Mr. H. N. Sethna said today. Dr. Sethna was participating in a convention of the "Changing face of technology: 1980-2000" organised by the Institute of Electrical and Electronics Engineers here. Pending this development, India could still be sure of continuous energy availability for future generations from breeder reactors. Nuclear energy production would increase steadily and its contribution to the world energy requirements would continue to rise. Dr. Sethna said modern technology had also given the necessary support to make nuclear energy an economical and reliable source for the energy requirements of many future generations, especially with the extensive application of breeder reactors. Pointing out that pressurised water reactors were well-developed systems and constituted the largest section of the power reactors in the world, he said the number of such reactors was likely to be trebled by the end of the decade. The next in line of popularity were the boiling water reactors. The global reserves of uranium, the only naturally occurring element which could be used as a fuel for fission reactors, were estimated at six million tonnes--of which 60,000 tonnes were in India--he said. Referring to the question of waste disposal from nuclear power plants, Dr. Sethna said there was very little high level waste produced by nuclear reactors. An operating reactor also discharged radioactive products into the atmosphere but the radioactivity released was less than that of a coal burning plant. [Excerpt] [Madras THE HINDU in English 13 Jan 83 p 9]

CSO: 5100/7051

NUCLEAR GENERATION TERMED ONLY ECONOMICAL OPTION

Karachi DAWN in English 23 Jan 83 Economic & Business Review p 1

[Article by M. Ziauddin]

[Text] THE PRESENT ENERGY crisis has once again thrown into bold relief the nuclear option which when studied alongwith other available options seems not only economical but also feasible.

Energy experts are really concerned with the way the officials are tackling the matter of energy. They say economic development is a direct function of energy consumption.

According to one estimate, Pakistan's combined reserves of coal, oil and gas are about 1,500 million TEC (tons equivalent of coal) and per capita reserve about 18 TEC. Compared to this per capita reserve of energy in US is 5,000 TEC and in the neighbouring India the per capita energy resources of 160 TEC are about nine times of those in Pakistan.

The population of Pakistan is likely to increase to 150 million by the year 2000. By that time, Pakistan would have exhausted all its known reserves of energy. The hydel resources are located in inaccessible areas and away from load centres. Therefore, the only options available are either to import large quantities of oil/coal or to go for nuclear energy.

Economists say that import of oil is [illegible] because it would mean billions of dollars, but coal may be considered. However, Pakistani nuclear scientists, not belonging to the government, insist that atomic energy is really the only feasible option.

PAEC's early plans

Very early in the day, Pakistan Atomic Energy Commission had made an elaborate programme. According to this programme, Pakistan was to have eight 600 mw nuclear stations between 1982 and 1990, nine stations of another 600mw each between 1991 and 2000 and seven stations of 800mw each between 1991 and 2000. That is, by the year 2000, we were to have 24 nuclear stations of a total 15,800mw.

Some time at the time of launching the Fifth Five-Year Plan it was felt that the nuclear programme as formulated by the PAEC was too ambitious and not feasible economically. It was, however, decided to set up three stations (Chashma units 1, 2 and 3, and Nuclear South Units 1 and 2) between 1985-94. The total capacity of these stations was to reach 3,000mw by 1994. This was actually a programme prepared by WAPDA. It was further extended to cater to the needs between 1995-2000 envisaging installation of six 1,200mw nuclear plants (7,200mw).

Independent nuclear scientists say that even this modified and economically feasible plan, if implemented at the right time could help Pakistan meet its growing energy demands after the year 2000 with reasonable ease.

Low priority

But all indications point to the fact that planners have decided to accord a very low priority to the nuclear option. The Fifth Five-Year Plan's allocation of Rs. 33.55 billion (3.35 billion dollars) for the energy sector was also meant for the Chashma nuclear project. But soon after the Plan was launched, this project was relegated to the files.

According to latest developments, the Chashma project is now on. Tenders for this project of 900mw have been invited and some European countries have already responded to the invitation. But in view of the colossal energy gap expected by the year 2000, even this station (which would have come on stream by the end of the Seventh Five-Year Plan if it started on time) is not likely to make any substantial difference.

Experts say the country's energy requirement would grow from the present 22 million TEC to 150 million TEC in 2,000 against the available reserves of about 1500 million TEC. The hydro power potential has been estimated to be 33,000mw of which not more than 15,000mw may be economically exploitable even in the long run. Furthermore it cannot be developed fast enough to meet the rapid rise in demand and a figure of about 8,000mw by the year 2000 seems to be the most that can be achieved against a demand of about 25,000mw.

These experts say some fuel has, therefore, to be imported if thermal power generation is to be stepped up. The only source of thermal energy besides nuclear fuel, they say, is oil which either has to be imported or discovered locally by intensive prospecting at a colossal cost with no guarantee that it would pay the right dividends.

Imported fuel

The prohibitively high cost of imported oil, however, has almost ruled out oil fired central stations as a competitive source of thermal power generation. Unless large sources of indigenous oil are discovered, it would be extremely unwise to use costly imported oil for power generation.

Therefore, in the opinion of independent nuclear economists, the only economic option was setting up of nuclear plants in addition to tapping the entire economic hydro potential and coal resources. They said, the total uranium feed required for nuclear power could be met from indigenous resources. Technical know-how and adequate trained manpower was already available in Pakistan.

In the opinion of these experts the implementation of the programme of nuclear power generation would cost less than oil and gas prospecting. They say, the country could also develop in the meanwhile all its gas fields of proven reserves as well as bring on stream the Dhodak oil field.

Independent planners say the nation was being taxed higher and higher to mobilise huge finances required to develop oil potential which was of very uncertain value. They say one could go on investing money in oil prospecting and still fail to strike economic wells. But if people were to be taxed for setting up nuclear station they will pay willingly because they will be certain they will get what they are paying for.

CSO: 5100/4704

DOUBT EXPRESSED OVER PAKISTAN'S NUCLEAR CAPABILITY

Kuala Lumpur ASIAN DEFENCE JOURNAL in English Jan 83 p 83

[Text]

The chairman of the Indian Atomic Energy Commission, Dr Homi Sethna recently expressed scepticism over the possibility of Pakistan's early capability of acquiring nuclear weapons.

Dr Sethna pointed out that Pakistan lacks the highly technical expertise in the vital final processes of nuclear weapons development. Although the Pakistanis have chosen the relatively direct uranium enriched method, its scientists have yet to master the technology of first producing sizable quantities of weapons grade fuel and secondly fabricating warheads.

Besides this, Pakistan does not presently have the industrial infrastructure necessary to be able to manufacture and deploy atomic arms, Dr Sethna assesses.

It came as some surprise that a man of Dr Sethna's position in the atomic energy field in India expressed his technical opinion on a subject which is crucial to Pakistan-India ties and security. However, considering more recent pronouncements from Pakistan, Dr Sethna's appraisal does not seem to 'square up' with the general impression in India and abroad that Pakistan is well ahead towards a breakthrough in its nuclear weapons development.

Western reports of Pakistan's nuclear programme have been from Western media and political sources. Accounts by Prof. Stephen Cohen, which appear to have prompted Dr Sethna's views, have dealt with the political and military aspects rather than with the technical. But Pakistan's unrelenting efforts to set up an enrichment facility, reportedly clandestine, have stressed intentions rather than capabilities. It was the reports on such efforts which Dr Sethna examined critically.

CSO: 5100/4704

BRIEFS

KANUPP CLOSED FOR SAFETY CHECKS--KANUPP, the Canadian designed nuclear reactor near Karachi, has stopped since Jan. 7 last, depleting the power position of the KESC by another 30 MW. A spokesman of Pakistan Atomic Energy Commission said yesterday it followed closure of the reactor to carry out safety checks. "In the nuclear plants," the spokesman said, "safety is the first consideration whereas in other conventional plants it is reliability which gets importance." KESC sources said KANUPP had informed the Corporation well in advance that a closure would be effected sometime in early January. The 30 MW shortage will mean a further aggravation of the power situation in the city, where already three KESC generating units are out of commission, for one reason or the other. The Provincial Industrial Facilities Board was informed by KESC on Jan 8 that overhauling of a 125 MW unit had been completed but no KESC official was available last evening to confirm whether it had been re-commissioned. Meanwhile the acting chief of KESC, Mr. Bashir Choudhry, has flow to Japan to discuss the proposal of buying a floating barge equipped with a 200 MW power generating turbine for Karachi. The Federal Government has already approved the project and the floating power station is likely to be commissioned later this year. [Karachi DAWN in English 13 Jan 83 p 1]

CSO: 5100/4704

ESCOM DENIES LACK OF INSURANCE COVERAGE

Johannesburg THE CITIZEN in English 1 Feb 83 p 11

[Text] Cape Town--Reports claiming that the nuclear power industry could not obtain insurance through normal channels were not correct, the Western Cape region of Escom said in a statement yesterday.

Escom had extensive insurance coverage from commercial insurance companies for the Koeberg power station, and the American, British, and European nuclear power industries were also covered entirely by policies from such companies, the commission said in a statement.

"In the past, anti-nuclear groups have claimed that nuclear power must be inherently unsafe as the insurance industry, which is the most experienced risk assessment group in the world, would not insure nuclear power plants. This claim is not valid.

"The Koeberg power station is covered by the following policies:

--Erection all risks insurance which covers Escom and the contractors during construction. This insurance is carried by South African insurers and provides, inter alia, for damage caused by sabotage and terrorism.

--Nuclear property damage insurance, which covers Escom property at Koeberg.

As was usual when "very large amounts" were involved, a group of companies had combined to provide the insurance, Escom said.

"The South African nuclear insurance pool, which includes local and overseas companies under the chairmanship of Mr M Conneley of Commercial Union, is providing property damage cover which is reinsured throughout the world with other nuclear pools.

"Insurance covering liability to third parties is also provided by the South African nuclear insurance pool," the statement added.

The Nuclear Energy Act of 1982 stipulated that Escom--as the licensee at Koebert--was liable for all damage to third parties resulting from nuclear incidents, the commission said.

"Escom, however, is not liable for damage to persons who have deliberately caused or contributed to accidents, or who are on the site or near nuclear hazard material without Escom's permission.

"As security to cover Escom's liability, the Minister of Mineral and Energy Affairs, with the concurrence of the Minister of Finance, has decided that insurance cover must be taken by Escom. Escom has complied with this requirement."

CSO: 5100/18

BRIEFS

KOEBERG DAMAGE--Two of the four explosions which recently damaged the Koeberg nuclear power installation occurred in each of the two containment buildings, the Minister of Mineral and Energy Affairs, Mr Pietie du Plessis, said yesterday. He was replying to a question by Mr D.J.N. Malcomess (PFP, Port Elizabeth Central). Referring to the estimated cost of repairing the damage, Mr Du Plessis said an extensive investigation regarding the nature and extent of the damage caused included very careful testing of equipment, which had not yet been completed. Answering part of Mr Malcomess' question which referred to the improvement of security at the site, Mr Du Plessis said security measures had been intensified in December 1982 and were on a level which would have been applicable to the next stage of completion. "Amongst others, it includes the further limitation of access to the nuclear buildings. It is considered inadvisable to disclose further information regarding security measures." Mr Du Plessis confirmed that it was possible for either reactor to go critical before the contract personnel were off the site.--SAPA [Text] [Johannesburg THE CITIZEN in English 3 Feb 83 p 4]

LAND FOR NUCLEAR DUMPING--Cape Town--Land has been acquired for the development of a national depository for nuclear waste, Dr J.W.L. de Villiers, chairman of the Atomic Energy Corporation announced yesterday. The department of Foreign Affairs and Information, names the land as being in Namaqualand. The site was found to be suitable because of its location in a geologically stable environment and with respect to minimal groundwater movement and appropriate geological and chemical soil characteristics.--SAPA [Text] [Johannesburg THE CITIZEN in English 3 Feb 83 p 8]

DELAY KOEBERG CAMPAIGN--Cape Town.--The "delay Koeberg" campaign is getting into its stride, the Western Cape chairman of the Progressive Federal Party, Mr Roger Hulley, said yesterday. The text of the petition reads: "We, the undersigned citizens of the Western Cape, call upon the Government not to activate the Koeberg nuclear power station until all construction activities have been completed and until independent safety and security assurances have been provided to the public."--Sapa. [Text] [Johannesburg THE CITIZEN in English 20 Jan 83 p 8]

CSO: 5100/15

HEAVY ION ACCELERATOR IN CAEN TO BEGIN EXPERIMENTS

Paris L'USINE NOUVELLE in French 16 Dec 82 pp 36-37

[Article by Pierre Virolleaud: "Nuclear Experiment, Ganil Is 3 Years Ahead"]

> [Text] The large national heavy ion accelerator (Ganil) in Caen produced its first particle beam at the end of last month and experiments will begin at the beginning of next year.

It was about 1960 when physicists, wanting to learn more about the laws of nature, had the idea of bombarding atomic nuclei with heavy ions (carbon, oxygen, neon) rather than with electrons or protons. The perturbations caused by much heavier projectiles was to completely renovate experimental techniques, and at the same time, to raise new doubts about the models designed to represent the nuclei. Several accelerators have been built for this purpose, especially in the United States, Germany and France.

However, the new equipment, jointly financed (557 million francs) and managed by the AEC [Atomic Energy Commission] and CNRS [National Center for Scientific Research] is at least 3 years ahead of its future Japanese and American competitors, because it is the only one at present that is able to produce a wide variety of accelerated ions within the energy range of 10 to 100 megavolts per nucleon. Our knowledge of "nuclear matter" within this range is still virtually nonexistent. We must therefore rely on assumptions.

In the vicinity of 10 to 15 megavolts per nucleon, nuclear matter would undergo compression effects. At about 30 megavolts per nucleon, phenomenon resembling shock waves would occur inside the target nucleus. At higher ranges, a boiling type phenomenon would be found. Physicists have no models for these energy levels, and for once, in basic physics, it is experimentation that will precede the theory.

However, nuclear physicists, who have already proposed some 50 experiments in Ganil, are not the only ones interested. Actually, about 10 percent of the equipment's activity will be reserved for the Interdisciplinary Center for Studies Using Heavy Ions [Ciril], specifically responsible for developing studies outside the nuclear sphere. Such studies include atomic physics, and those even closer to direct applications involve the physics of condensed matter. We might, for example, study the effects of a deep implantation of ions in metals, because we scarcely know how to implant ions beyond the micronic surface layer. As of now, these effects can be studied in mass (up to several millimeters), and the preparation of metastable alloys would thus lead to the development of new materials.

At present, the upward industrial growth in Ganil is not negligible. In fact, the production of four cyclotrons (two of which are a new type with separated sectors), intermediary transfer systems, injection and ejection devices has resulted in a few technical achievements, especially in the area of hard vacuum and measuring and control instruments. The two separated sector cyclotrons are each provided with a chamber 4 meters high, 9 meters in diameter and weighing 55 tons. The machining of its austenitic stainless steel parts, made by Neyrpic, attains an accuracy in some places of less than 1 millimeter. Physimeca, a small 150-person firm at Saclay has succeeded in using cryogenic pumping using helium at 20°K without a liquid nitrogen screen. The hard vacuum made it necessary for Rhone-Poulenc to perfect teflon glass printed circuit supports at low degasification rates.

Insulated lead-throughs have been designed by the Verelec Company which can hold some 60 wires in a very small volume. In the area of automatism, we may also mention Sermm in Ozoir-la-Ferriere, which has developed electromechanical precision position encoders, or the Compagnie Continentale de Signalisation [Continental Signalling Company], responsible for the software and hardware used to control radiation in and the access to all rooms. However, there is no question that AEC and CNRS engineers, who managed the project and a large part of its engineering, are responsible for the greatest achievement: that of a highly complex technological project implemented within its deadlines and that scarcely exceeded (by 7.5 percent) the estimated costs established in 1977.

12204
CSO: 5100/2540

EQUIPMENT PROBLEMS CAUSE PLANT STOPPAGES

Paris L'USINE NOUVELLE in French Supplement to 11 Nov 82 pp 6-7

[Article by Dominique Benasteau: "Nuclear Plants: Controversy Over Safety Versus Availability"]

> [Text] Recent failures of French nuclear plants have again set off controversial discussions about safety versus uninterrupted current supply. These failures reveal how slow lessons are being learned from the Japanese experience and that the nuclear tool cannot escape facing the problems of inexperience.

When winter is here, how many units will be available? A little riddle that is not at all funny to EdF--as we can imagine--and which worries industrial manufacturers, and with good reason. The facts are there: since the beginning of the year, plants are shutting down one by one: Gravelines 1 in January 1982 (put back into service only last July), Fessenheim 1 in March 1982, Bugey 2 in July, followed by Bugey 4 in September. Unavailabilities are being added to an already tense situation. The year 1982 was penalized right from the beginning: after 18 months of operation, 7 units were supposed to be subject to a generalized inspection which would tie them up for 4 months. Yet, here we are with an equivalent of three units being shut down for "technical reasons." These problems actually cover two distinct areas of varying degrees of seriousness.

The first area is the problem of inexperience and involves the first series of plants of the new generation established after 1977 (program contract #2). For the secondary part, EdF wanted to diversify its orders and called upon CEM [Electromechanical Equipment Co.], which made use of a Brown Boveri license before rejoining the Alsthom group, certified manufacturer of the equipment for contract #1. Today, the two units B1 and B2 of Saint-Laurent, are in a long-term shutdown status for incorrect operation and incorrect vibration behavior from the drier-overheater units. These units, located between the high pressure input body of the turbine and the low pressure body, are being redesigned. Chinon units B1 and B2 are also suffering from the confidence given to Brown Boveri, both for the selection of materials and for the design. Program contract #2, also for reasons of inexperience, is expected to show weaknesses at the alternator level. Such failures, which are comparable to those found in program contract #1, look like slips.

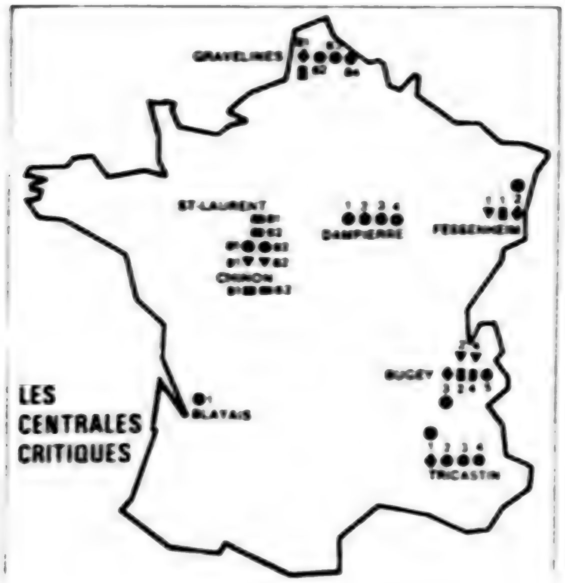
The second source of problems are spindles of a few centimeters. Although it seems like just a detail, the "spindle affaire" is making people worried and surprised. People are worried, because the Inconel super-alloy parts are used to center the guide tubes of the control clusters. This means that if there are some 60 tubes per reactor (and therefore 120 spindles), and being deprived of part of the reactor's regulator in the event of a failure is not at all permissible. The surprise comes from the fact that France apparently discovered in 1982 how extensive the problem was that arose for the first time in 1978. CFDT [French Democratic Confederation of Labor] was the first to notice that the equipment used to replace the spindles on the guide tubes is still being perfected in France, while in Japan, it was perfected from September 1978 to the summer of 1979, and therefore in less than 9 months.

Credibility of French Nuclear Equipment

Meanwhile, at Gravelines, EdF simply replaced the defective tube-spindle assembly. Following a televised control deemed to be satisfactory, the plant was put back into operation. The Fessenheim shutdown triggered by a suspicious noise (piece of spindle "during an inspection" in the main primary circuit) was going to hold a few surprises. The outlet of the guide tube, one of the spindles of which was damaged, caused the second one to break. A decision was then made to take out all of the tubes and to replace them by others. These were taken from the equipment of units under construction, which explains the long shutdown until the end of the year. The policy of replacing all spindles was, moreover, imitated by the Japanese. It seems they were right to do so, because 27 of them were broken or damaged at Fessenheim. As a result, CFDT demanded the shutdown of several other units, in spite of EdF's assurances.

All the same, the Japanese lesson bore its fruit: the causes for the spindle damage were investigated. At Framatome, it was found that the heat treatment, the part design, the stresses caused while fastening the part were responsible for the stress corrosion which caused cracking, even ruptures on the spindles. Modifications of these risk factors were therefore made as the execution of program contract #1 progressd. For future plants, a new spindle standard, with an improved form, optimal heat treatment and lower tightening torque, should eliminate all problems. The same result is expected for 15 other units, already benefiting from an improved heat treatment.

We are left with two critical families. One is Fessenheim 2 and Bugey units 3, 4 and 5. It was already attacked by the shutdown of Bugey 4, whose spindle was found to be broken during a maintenance operation. As for the latter family, it is the most sensitive one and includes Fessenheim 1, Bugey 2 and Tricastin 1. Stoppages of the first two gave DFCT the opportunity to demand the shutdown of the third, and to question the efficiency of certain inspections. At Fessenheim 1, the spindle rupture was seen, but not heard, because the noise was not loud enough (although damage on the steam generator was). At Bugey 2, the incident occurred following a routine examination during which nothing unusual was detected. To permit a correct evaluation, CFDT would also like to see Bugey 3 and Fessenheim 2 shut down. In all, with the Gravelines inspection asked for, four units are suspect.



The Critical Plants

Seven units had to undergo a generalized inspection. For "technical reasons," three others were shut down, bringing the plant coefficient of availability down to 44 percent.

1. Spindle problems reported
2. Possibility of spindle problems (CP1)
3. Drier-overheater problems
4. Plant shut down for technical problem (spindle or drier-overheater unit).

As for EdF, the problem was taken very seriously, and interventions to replace the spindles were planned according to the age and vulnerability of the units. None were enrolled during shutdowns in 1983 and they were therefore extended from 5 to 6 weeks. However, will they stick this period out, or will they show the same disturbing symptoms as the other four units already shutdown. On this assumption, EdF is pulled between safety considerations and the need for a continuous current supply, and deep down it is concerned about the reputation of the French nuclear industry. Not long ago, experts from the International Atomic Energy were still praising the exceptional coefficient of availability of the PXR units operating at 900 megawatts (65 percent), a value far above the world average (56 percent) for units of equivalent age and power. EdF had set a normative value of 62 percent for 1982, encouraged by the 63 percent availability of the PWR group in 1981. The prediction for the year is no more than 57 percent, and in August, a rate of 44 percent had to be announced. From the financial standpoint, each type of incident will have contributed 1 billion francs (some sources say 2) to the deficit of 8 billion francs that EdF is already burdened with.

The blow to the credibility of French nuclear equipment is hard to put in figures. The effects on export possibilities will depend on the "epidemic" that hits the spindles in the months to come. On the national level, the spotlight on spindles is gradually switching focus to the cost of the nuclear kilowatt-hour. If this is known to be of interest, is this not on the assumption of an annual operation of more than 6,000 hours associated with an availability of some 70 percent?

12204
CSO: 5100/2540

NETHERLANDS

POSSIBLE URENCO URANIUM SALE TO TAIWAN VIEWED

Rotterdam NRC HANDELSBLAD in Dutch 10 Jan 83 p 7

[Commentary by An Salomonson: "Fission Material for Taiwan Could Be Salvation of URENCO"]

[Text] Since the government in 1978 approved the contract between the Dutch-British-German joint venture URENCO [Uranium Enrichment Consortium] and Brazil to supply enriched uranium, the further export policy of URENCO has been the subject of sharp political discussions. Meanwhile, however, under the auspices of the International Atomic Energy Agency [IAEA], a study group -- called CAS [expansion unknown] -- has begun formulating general rules for nuclear world trade. While these activities are in progress, the "troika" will not unilaterally set new and more specific export conditions because this could interfere with the CAS negotiations. Hence, for the time being every transaction will have to be ratified separately by the three governments, as stipulated in the Treaty of Almelo.

This also applies to a possible contract with Taiwan, the chances for which are not as dim as some people would suggest. This possibility was brought up for the first time in 1979 in the mixed committee, which includes government representatives of the troika. All diplomatic statements made the last few days notwithstanding -- the Taiwanese are clearly interested in enriched uranium from URENCO.

Like all countries which do not have their own sources of energy, they want to diversify their imports. Furthermore, there is an enormous balance of trade surplus with the Netherlands (as well as with the FRG and England). Taipei wants to balance this in order to prevent conflicts, such as those which have arisen between Western Europe and Japan.

The problem is that the three governments must apply their export standards to a country they have not recognized. Even though in 1970 Taiwan became a party to the Non-proliferation Treaty, the treaty with the IAEA, required by this membership , on oversight of all nuclear installations in the country (the so-called full scope safeguards) was not implemented, although it was ready. Meanwhile, China had become a member of the United Nations and, as a result, Taiwan had to give up its United Nations membership and thus also its membership in the IAEA.

Yet, all nuclear installations in Taiwan are being inspected by the IAEA as a result of a trilateral agreement with the IAEA and the United States, which supplied the installations in question.

In addition, Taipei has made a statement to the effect that it will stick to the stipulations of the Non-proliferation Treaty, even though it is not legally obliged to do so. Hence, the basic requirement of "full scope safeguards," stipulated by URENCO for every transaction, is de facto met.

Furthermore, Taiwan does not have the capability of producing plutonium once the uranium has been burned up. From the very beginning, America has been opposed to Taiwan having a reprocessing installation at its disposal. The Taipei government has resigned itself to this in the knowledge that it cannot afford to provoke its patron, to whom it owes its continued political existence.

Normally speaking then, an oversight agreement with Taiwan should run into less difficulties than was the case at the time with Brazil (which was not a member of the Non-proliferation Treaty and which had the capability to reprocess). Assuming that no convincing objections of another kind are raised against the supply -- and this does not seem very probable as fission material for peaceful purposes cannot be compared to submarines, at best to oil --, the question then is whether a formula can be conceived to make arrangements with a non-recognized state.

Well, under certain circumstances such a formula is not unthinkable. In Bonn and London, where for the time being they are much more positively inclined toward a contract with Taiwan than they are in the Hague, ideas on the subject seem to be taking shape.

This does not mean that from a non-proliferation point of view, all objections have thus lost their force. In the case of Taiwan, even the best imaginable security agreement would rest on a somewhat shaky base. Local inspection is carried out by the IAEA. For the time being, China is not a member of that agency. If, within the framework of their new outward opening, the Chinese were to decide to join the IAEA, then it would not be unthinkable for them to object to that inspection. Indeed, the existence of Taiwan is indirectly recognized by this inspection.

However, such an action, even though not unthinkable, is not very probable. It would be particularly in Peking's interest, via this inspection, to be kept up to date on the nuclear activities of its arch-enemy.

Another objection, which has been raised here and there, specifically that in another year or so Taiwan could decide to build nuclear installations by itself without subjecting them to oversight, does not seem very convincing either. Such an initiative would mean a break with the United States and, as we said before: Taiwan will know better.

While the objections to a contract with Taiwan do not seem insurmountable from a non-proliferation standpoint, on the other hand there is a clear argument in favor of it. As early as 1979, when Taiwan was first mentioned as a possible client for URENCO, it appeared that among the troika partners, the FRG was very much in favor and England was definitely not against such a deal.

Now, noticeable irritations had already arisen within the troika 5 years ago because of the Dutch opposition to the sale to Brazil. Since then, the continuation of the joint venture is no longer a matter of course for the partners. If another conflict were to arise about Taiwan, the FRG -- which has a much larger balance of trade deficit with Taiwan than the Netherlands -- could well withdraw from the troika and could secure the order by itself for its brand-new reprocessing plant in Gronau.

A straw in the wind is the order for Brazil which is not, as originally planned, being filled at Almelo but at Capenhurst, in Britain, because the partners had more than enough of the unreliable Dutch complaining.

Our Calvinists, who are once again, bible in hand, marching into battle against the sale to Taiwan, could take this lesson to heart. A nuclear "going it alone" by the FRG is surely the very last think they could wish for, isn't it?

9463
CSO: 5100/2547

SEISMOTECTONIC MAP PROJECT FOR IBERIAN NUCLEAR PLANT SITES

Madrid ENERGIA NUCLEAR in Spanish Nov-Dec 82 pp 395-401

[Article by A. De Acha, of the JEN Nuclear Safety Department: "The Iberian Seismotectonic Map Project for Selection and Evaluation of Nuclear Plant Sites"]

[Text] The initial version of this article was submitted by its author at the Second Meeting of the Spanish-Portuguese Protocol on Cooperation in Nuclear Safety, held at Lisbon on 8 July 1982. The deliberations on the topic have been arranged according to points, to facilitate their discussion.

1. Introduction

The methodologies most used in determining the seismic subparameters of a nuclear plant site, for example, the one contained in the former, now controversial, Appendix A of the United States' 10 CFR 100, and the one described in Safety Guide 50-SG-S1, which the International Atomic Energy Agency (IAEA) published in 1979, reproducing much of the aforementioned Appendix A, initially entail the determination of certain geological and seismic features and of the interrelationships among the latter in an extensive area surrounding the site to be evaluated. The fact that the seismotectonic map of a country is a good indicator in this regard and, moreover, not confined to one point in the area to be considered, but rather associated with the entire territory thereof, demonstrates the feasibility of the existence of such a map, when the country involved proceeds to select and evaluate its nuclear plant sites.

Nevertheless, the absence of a national seismotectonic map unfortunately occurs all too often, not only before the initiation of the pertinent nuclear program, but also after the latter has started and when its implementation is even well under way. Hence, the seismic studies related to such a program are often beset with significant flaws, inasmuch as the absence of a common seismotectonic context, both in the selection of zones, areas and sites per se in a particular country, and in the evaluation of specific locations therein necessitates the repetition of many studies and can involve different degrees of conservatism in this research, and there is even the possibility of its giving rise to considerable inconsistencies among the various solutions that are adopted. Furthermore, these flaws understandably raise the expenses to be incurred, not only because of the increase in effort that they always entail, but also owing to the additional charge often stemming from overevaluation, and even from evaluation with a lesser degree of conservatism than should have been applied.

Without placing too much stress on it, because it has only the value of past history, it is fitting to state, very briefly, that the attempts made to draw up the seismotectonic map of Spain for the selection and evaluation of nuclear plant sites have been varied. None of the peninsular seismotectonic maps devised to date has proven suitable, owing to the time that has elapsed since their execution, and also because of their orientation, for the purpose proposed herein; although their contents could nevertheless be used, at the proper time , as basic information for attaining the goal sought now.

The Nuclear Energy Board (JEN), for some time, and the Nuclear Safety Council (CSN), since its establishment in 1981, have been requesting the preparation of the map in question. The former of these two agencies even contributed, in its time, in a greater or lesser degree, as the case may be, to the holding of four technical meetings on the subject in which there was participation, in addition to its own, by the Geological and Mining Institute of Spain (IGME), the National Geographical Institute (IGN), the Schools of Geological Sciences of the Complutense [Alcala de Henares] University of Madrid, and the University of Granada, the Madrid Higher Technical Engineers School and the Adaro National Mining Research Enterprise, Inc (ENADIMSA), and even by such foreign specialists as Mr Espinosa, from the U.S. Geological Survey, the Messrs Iaccarino and Magri, of the National Nuclear Energy Commission of Italy, and Profs Ambrasseys and Lomnitz.

Recently, IGME, through ENADIMSA, has written a "Methodology for Devising the National Seismotectonic Map," a more extensive project than the one considered in this communication, but one which could become a starting document for a general discussion among the various entities affected by this work. IGN, in turn, is already involved in the matter, because it has, for some time, and at the request of the Spanish nuclear safety agency, been serving as seismological consultant to the latter. And, finally, the country's electrical enterprise, which has expressed the feasibility of this map on constant occasions, has decided to be one of the leaders in the matter, and has joined the others interested in it, through the Spanish Atomic Forum (FAE).

There is an awareness of the Portuguese concern over the issue. The meetings of the Spanish-Portuguese Protocol on Cooperation in Nuclear Safety, and of the Spanish-Portuguese Accord on Cooperation on Nuclear Safety in the Border Nuclear Facilities have, in turn, demonstrated the interest of Spain and Portugal in the joint approach to, and treatment of the matter.

The following sections of this article relate to the project for the Iberian seismotectonic map applicable to the nuclear field. Nevertheless, they describe only a few general considerations of the matter, because it is not yet time to specify questions in detail.

The aforementioned considerations are not intended to be exhaustive, much less definitive, and it is desired that they be completed and criticized. And it is to be hoped that the intent cited herein will not be exhausted by too much bureaucracy and lack of coordination and funds, but rather that it will quickly take shape in something definitive, and soon become a reality.

2 General Considerations

2.1. Some principles to be taken into account in preparing the Iberian seismotectonic map for the selection and evaluation of nuclear plant sites

(1) The seismotectonic map in question, which should avoid scientific approaches that are out of place, in view of its preeminently practical nature, would be used initially for the selection and evaluation of sites for nuclear and radioactive facilities of the first rank. Its use could later be extended to other major construction which need not be enumerated now.

(2) The area covered by the aforementioned map should not be confined to Spanish territory and its coastal environs, but rather must also include the Portuguese, and its environs, for both technical, and economic and political reasons. It would even be fitting to have it correlated, from its beginnings, with the French seismotectonic map, the first version of which has just been completed (Figure 1), and with the North African one that is being prepared; and to have it included, in turn, in the seismotectonic project for the Mediterranean basin, a matter which was discussed at the meetings held among the safety agencies of Spain, Greece, Italy and Portugal, and which it would be suitable to revive again, since it has been somewhat forgotten. The same thing might be said for any other attempt in this respect affecting Western Europe in any way, whether already begun or yet to begin.

(3) The map which is the subject of this article will be applicable at present only to the regional seismic studies, whether they relate to the selection of zones, areas or sites per se, or to the evaluation of the macroenvironment of a specific site; and its existence will never warrant the exclusion of subsequent research relating to the meso- and microenvironment thereof. Hence, an appropriate scale for it would be 1:1,000,000, which would, understandably, have to be based on notes 1:250,000 or greater.

(4) The seismotectonic map outlined herein, which attempts to correlate the seismicity (Figure 2) with the structural context (Figure 3) necessary for a better understanding of it, is not a seismic risk map, but is a good backup for the latter. Obviously, it could, with the pertinent adjustments, also serve as a support for a geological risk map based on displacements in faults; although this second possibility, despite the great interest associated with it, is a departure from the goal sought, and its consideration is also premature.

(5) In view of the contents of the foregoing paragraph, seismicity must clearly take precedence over tectonics on the map in question. Hence, the latter will be included on it only insofar as necessary for a better interpretation of the former. Nevertheless, it must be admitted that specifying this limit lends itself to controversy; but if it is desired to be operative, there must be an option to accept one.

(6) It is considered essential for the project in question to have, as promptly as possible, a good revision of the Iberian seismic catalog (Figure 4), on which there has been collaboration by historians who are experts on the subject, one that also includes all the earthquakes close to the peninsular which might be of concern to it. The greater or lesser degree of sophistication assumed in the procedure to be

followed in the execution of the seismotectonic map outlined herein is useless if it is not based upon reliable seismic data; and the use of the historical seismicity, which need not be dispensed with, but which requires a prior in-depth assessmention thereof, could lead to interpretations that are quite unscientific and enormously burdensome from an economic standpoint.

(7) Also extremely important for the project outlined herein is to have available, as soon as possible, a card file on significant peninsular structures. Maximum care must be taken in preparing the format of the file card (Figure 5) to be used, as well as in the initial compilation and progressive updating of each case.

(8) The association of seismisms with the surface structures, which is usually made on the basis of the misinterpreted American methodology, is very easy, but overly simplistic. It is dangerous to dispense with other deeper structures, which could really have an association with certain earthquakes.

(9) The general features of the different methodologies that could make use of the seismotectonic map in question should be determined before devising the project for the latter definitively; because there might be a possibility of including in the aforementioned map certain details based on one of these methodologies. However, such details should not represent any limit on the use of the map in the other methodologies being considered, because the instances of counting on it must be the maximum possible number.

(10) The seismotectonic map discussed in this article should incorporate the notion of a seismotectonic province or domain because, although the end goal thereof is the determination of the seismogenic structures and of their repercussions on the Iberian Peninsula, this determination is an unattainable ideal at present, and the notion in question is a conservative view of the present status in the area, capable of countering the many gaps that exist on the subject,in its own way. Nevertheless, it must be admitted that such a notion could prove to be so exclusive in a country with certain dimensions and with a particular geology and seismicity that its replacement could be attempted with another compromise,when confronted with the selection of nuclear plant sites in that country.

(11) The contents of the aforementioned map should not be overly ambitious, nor seek to attain an exaggerated perfectionism, by attempting something almost definitive. Hence, the map in question would contain only the information deemed necessary for the best fulfillment of its end goal, and must be endowed with a certain dynamics that would, without great haste but without too much apathy either, allow for its gradual improvement in subseqent editions; because it seems better to have something that can be perfected than not to have anything.

(12) Inasmuch as attempting too much originality in the map in question, to some extent dispensing with all the background data in existence on the subject, would prove counterproductive, this background data should be collected, considered and discussed to the maximum degree before devising the project. It is thought that one such item, specifically, the French seismotectonic map published in 1981, which was mentioned earlier, is the best basic documentation available today, both from a technical standpoint and from that of organization and handling of the subject.

(13) The aforementioned map project should initially entail the making of a series of determinations, premises, criteria, etc. These will reflect not only the international or foreign standards relating to the subject and the current state of the art therein, but also the individual seismotectonic conditions of the geographical area in which the Iberian Peninsula is located and the specifics thereof.

(14) The project in question should consist, essentially, of an analytical phase and another that is synthetical. The former would include the preparation of subject maps on historical seismicity, instrumental seismicity, neotectonics and geophysical discontinuities detected by traditional methods as well as by radiometric ones and outlines; and the latter would be associated with the preparation of the seismotectonic map itself, as a synthesis of the six former ones. This seismotectonic map, like the subject maps, would attempt to be highly objective; but a considerable subjective content would always have to be acknowledged in them, because, like any geological plan, it is a function not only of the real geology and of the use to be made thereof, but also of its author who, living in a certain space and time, will moreover find himself affected by both circumstances.

(15) The analytical phase of the aforementioned map, in view of the urgent need for it, must have a cutoff date for the information to be included therein, but for very strongly warranted exceptions. The desire to consider documents subsequent to a certain date in the subject maps, and even to conduct new research to improve such maps after that date, would make the project impracticable. And it would certainly be made impossible by an attempt to make the observations that are provided in each one of these maps uniform; because the data coming from some locations on the peninsula and from others are still quite dissimilar, owing to the greater or lesser complexity of those locations and the better or worse amount of information available on them, and it would prove foolish to attempt to equalize it covertly.

(16) The aforementioned map should not be too sophisticated, either from the standpoint of its content or from that of the symbology adopted in it; so that its use will not turn out to be overly troublesome. This premise, however, does not mean that immediate solutions to the problems that are posed would have to be provided on the basis of overly simplistic views.

(17) The use of the seismotectonic map that is the subject of this communication, which is not to be considered something to limit initiative, but rather as the best support for the latter, should not be mandatory by nature, but rather a recommendation. The one bound by it would have to use it, in principle, unless, whether on the basis of the subject maps or other grounds, he proves adequately that his conclusions regarding the case under consideration are better than those contained on this map.

(18) The seismotectonic map in question should be viewed only as a snapshot of the subject at a particular time and in a particular situation. Hence, there will not be attached to it either greater or lesser value than it deserves, because it is not intended to establish dogmas, since it is open to all criticism, which is even deemed highly feasible; but it is not intended to become an odd document with little or no practical use either.

(19) The seismotectonic project discussed herein should become (as is occurring in France) the driving force for many research projects associated with it either

directly or indirectly; and, similarly, it should to some extent become the coordinator of all of them.

[illegible] Some comments on the practical completion of the Iberian seismotectonic map for the selection and evaluation of nuclear plant sites

(20) The Spanish CSN and the Office of Nuclear Protection and Safety (GPSN) of Portugal should be the sponsors of the Iberian seismotectonic map proposed herein, in their respective countries; because the first use therof will relate to the selection and evaluation of nuclear plant sites in both territories. Therefore, these two entities should jointly prepare a fundamental document on the subject, to be submitted for discussion and approval by all those involved in the project.

(21) The organization to be adopted for the preparation of the aforementioned seismotectonic map will be very simple, and eminently practical; and hence it will dispense with any complications that are not really geared to the best execution of it.

(22) The project in question, which will take into account the criteria on nuclear safety contributed by CSN and GPSN, with the cooperation of the Spanish JEN in the first instance and that of the Portuguese agency or agencies which are appropriate in the other case, will be devised essentially on the basis of the geological and seismic guidelines indicated by IGME, with the cooperation of the Public Works Geological Service and the IGN of Spain, as well as by the pertinent groups in Portugal. The initial users of the map discussed herein, the electrical enterprises, will also be required to express their views on the matter, in its preliminary phase.

(23) Two technical teams will be established, one Spanish and the other Portuguese, for the execution of the pertinent subprojects. Each of them, to be comprised mainly of geologists, geophysicists and seismologists, must have one person in charge of a subject map, and another in charge of the synthetic one. They will have to require full dedication of all their members, and attempt to station them in the least possible number of locations.

(24) Each of the teams will be in constant contact, in the manner deemed most fitting, with the competent agencies in the field of geology and seismology, as well as in that of nuclear safety, in the pertinent country. Both teams may request advice on completely identified matters, through the channels and with the means decided upon by whatever agencies (research centers, universities, higher schools, petroleum entities, engineering facilities, IAEA, etc.) and individuals they may regard as appropriate. Except in instances wherein special reasons warrant otherwise, those agencies and these individuals must be Spanish or Portuguese, as the case may be.

(25) A timetable will be established for the completion of the project. This timetable might start on the basis of the first version of the map in question being due for completion by 31/12/86; an assumption that would entail a cutoff date of about 31/12/82 for the information to be collected.

(26) The seismotectonic map in question would be paid for by the administration and the electrical enterprises assigned for each of the two subprojects. The type and amount of the economic participation would be decided at the appropriate time.

(27) The nuclear safety agency and its collaborator(s) in this field, the competent ones in the fields of geology and seismology, and the electrical enterprises of each country will set up a joint commission to monitor the work in their area of influence. These commissions will analyze, in the manner and at the time to be specified, the preparation of the project in question, its budget, the gains made, the fulfillment of the terms and of the anticipated costs and any possible deviations that may arise along the way, as well as the solutions given for the latter.

(28) CSN and GPSN must be the main coordinators of the Spanish subproject with the Portuguese one, and vice versa. Obviously, they will have the pertinent collaboration for this purpose.

(29) The use that is made of the map in question for the selection and evaluation of nuclear plant sites will be the responsibility of CSN in Spain, and of GPSN in Portugal. The other Spanish or Portuguse agencies involved in its execution will be consulted regarding such use when that Council or Office, as the case may be, deems it feasible.

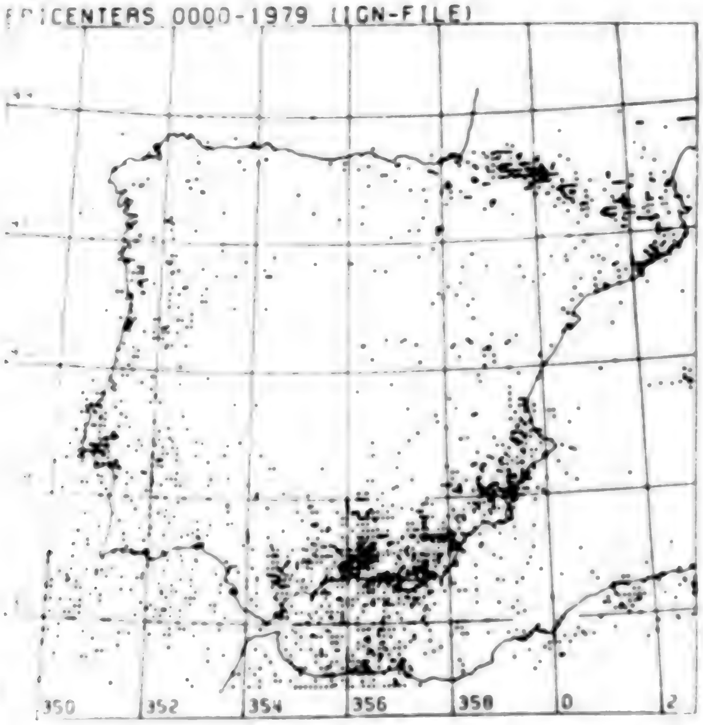


Fig. 2. Mapa de epicentros de la Península Ibérica durante el periodo 1900-1979 según información del IGN.

Figure 2. Map of epicenters of the Iberian Peninsula during the period 1900-1979, based upon information from IGN.

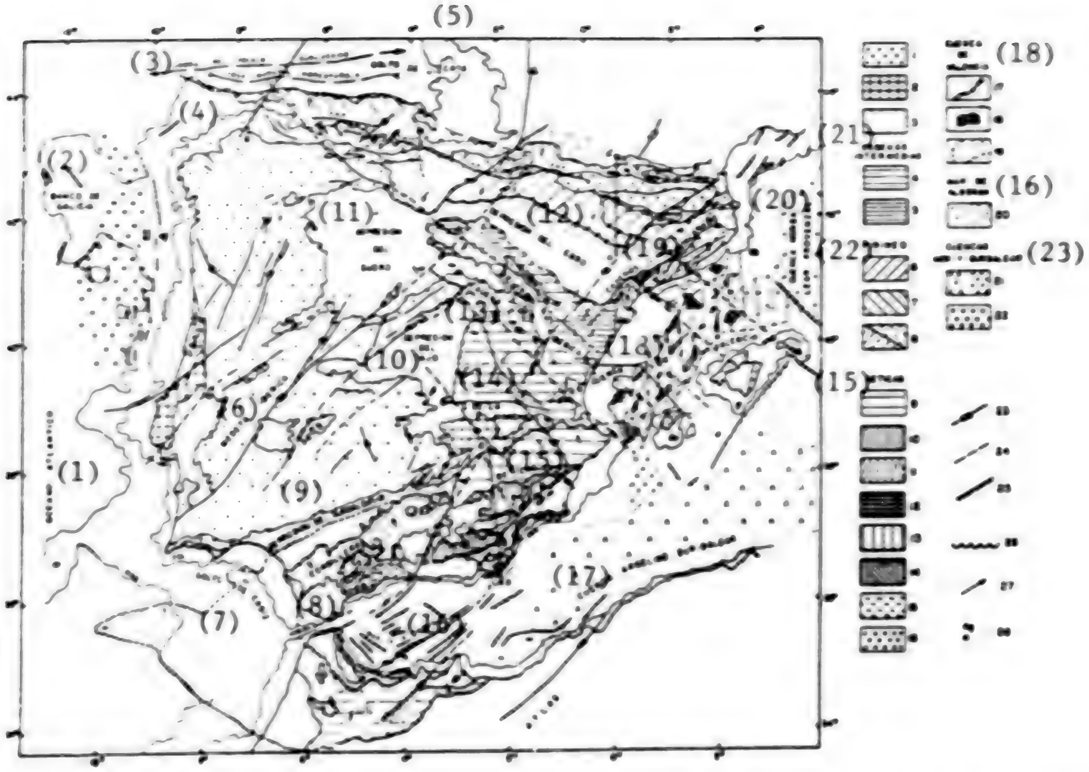


Fig. 3.–Esquema tectónico de la Península Ibérica y áreas limítrofes de la línea de costa según R. Capote (1978).

Figure 3. Tectonic diagram of the Iberian Peninsula and areas bordering the coastline, according to R. Capote (1978).

Key:

1. Atlantic Ocean
2. Shoal of Galicia
3. Beginning of South Biscay continental shelf
4. Northern Spain marginal dip
5. Gulf of Biscay
6. Iberian plateau
7. Gulf of Cadiz
8. Mountain ranges
9. Guadalquivir depression
10. Tagus depression
11. Duero depression
12. Ebro depression
13. Iberian chain
14. La Mancha depression
15. Beticas [Andalusian areas]
16. Sea of Alboran
17. South Balearic Algerian basin
18. Valencia basin
19. Catalonian chains
20. Provencal North Balearic basin
21. Intermediate chains
22. Pyrenees
23. North and South Balearic basins

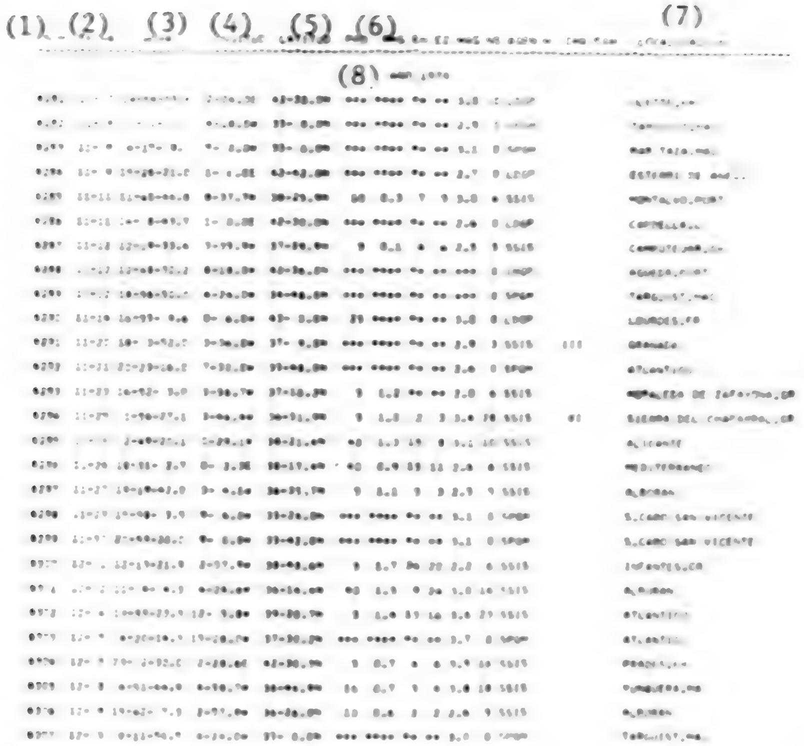
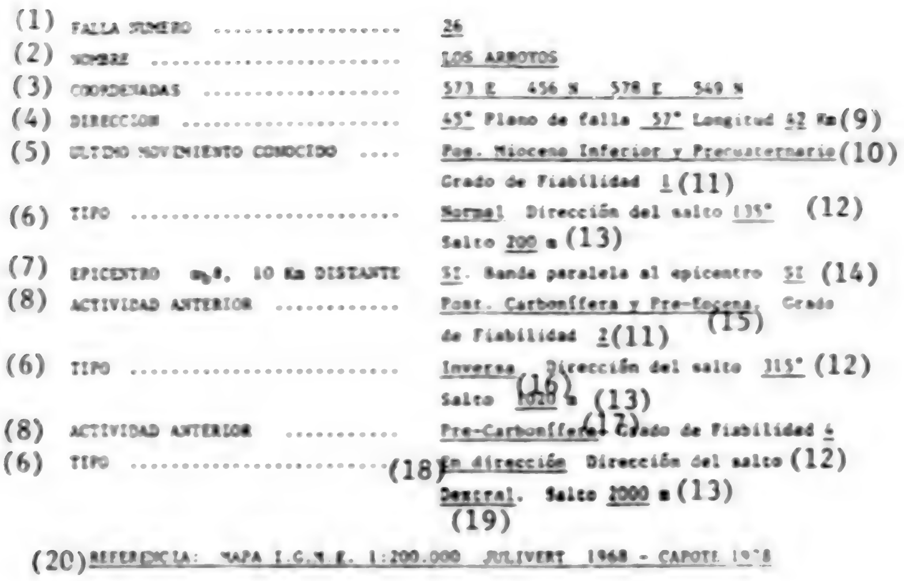


Fig. 4. Salida del Banco de Datos del IGN, relativa a la revisión en curso del Catálogo Sísmico de la Península Ibérica, según información de dicho Instituto.

Figure 4. Output from the IGN Data Bank relating to the revision that is under way of the Seismic Catalog of the Iberian Peninsula, according to a report from that Institute.

Key:

1. Number
2. Date
3. Hour
4. Longitude
5. Latitude
6. Average
7. Location
8. Year 1979



(1)	FALLA NUMERO	26
(2)	NOMBRE	LOS ARROTOS
(3)	COORDENADAS	573 E 456 N 578 E 549 N
(4)	DIRECCION	45° Plano de falla 57° Longitud 42 Km (9)
(5)	ULTIMO MOVIMIENTO CONOCIDO	Pos. Mioceno Inferior y Precuaternario (10) Grado de Fiabilidad 1 (11)
(6)	TIPO	Normal Dirección del salto 135° (12) Salto 200 m (13)
(7)	EPICENTRO m_b4, 10 Km DISTANTE	SI. Banda paralela al epicentro SI (14)
(8)	ACTIVIDAD ANTERIOR	Post. Carbonífera y Pre-Eocena. (15) Grado de Fiabilidad 2 (11)
(6)	TIPO	Inversa (16) Dirección del salto 315° (12) Salto 1020 m (13)
(8)	ACTIVIDAD ANTERIOR	Pre-Carbonífera (17) Grado de Fiabilidad 4
(6)	TIPO .... (18)	En dirección Dirección del salto (12) Dextral (19). Salto 2000 m (13)

(20) REFERENCIA: MAPA I.G.M.E. 1:200.000 JULIVERT 1968 - CAPOTE 1978

Fig. 5. Ficha normalizada de una falla que se incluye, a modo de ejemplo, en el informe del IGME citado en la Introducción de esta comunicación.

Figure 5. Standardized file card on a fault, included as an example in the IGME report cited in the introduction to this communication.

Key:

1. Fault number
2. Name
3. Coordinates
4. Direction
5. Last known movement
6. Type
7. Epicenter m_b 4, 10 km distant
8. Previous activity
9. 45° fault plane 57° longitude 42 km
10. Lower Post-Miocene and Pre-Quarternary
11. Degree of reliability
12. Normal direction of the throw 135°
13. Throw 200 m
14. SI. Band parallel to the epicenter SI
15. Post-Carboniferous and Pre-Eocene
16. Inverse
17. Pre-Carboniferous
18. In direction
19. Toward the right
20. Reference: IGME Map 1:200,000 Julivert 1968 - Capote 1978

2909
CSO: 5100/2550

HISTORY OF COUNTRY'S URANIUM ORE PROCESSING

Madrid ENERGIA NUCLEAR in Spanish Nov-Dec 82 pp 445-454

[Communication to the International Conference on Experience Gained in the Nuclear Electric Field, Vienna, 13-17 September 1982, by J.M. Josa, of JEN: "30 Years of Uranium Ore Processing in Spain"]

[Text] Summary

The Spanish experience in the treatment of uranium ores includes ores of a pegmatitic type, lode types, sandstones, enrichments in metamorphic sediments, radioactive carbon and unconventional sources, such as phosphoric acid and copper water. Studies have also been made on the beneficiation of very poor ores, of the paleozoicquartzite type. The recovery of by-products (copper) is included in this experience.

The technologies covered relate to the physical concentration, the combustion and roasting, the alkaline and acid conventional treatment, and the static and bacterial leaching. Special attention has been given to the recovery of uranium from liquids and the development of equipment for this (especially in extraction with solvents and continuous ion exchange).

The concern has not been confined to the conventional-sized plants, for 200-3,000 t/d. The interest in beneficiation for small mines or those in remote areas has led to the development of mobile and recoverable modular plants. The reduction of the environmental impact is another area of concern.

The purification of uranium concentrates and the procurement of products of nuclear purity, both through the wet method (nitric acid - TBP) and the dry method (fluidized beds), is another feature included in the Spanish experience.

The essence of the past 30 years of studies and industrial practice, as well as the innovative projections for the future, could constitute a good foundation for medium-sized countries which become incorporated into the uranium industry. The consideration of the Spanish experience, indicating what is worthwhile continuing and what to avoid, could facilitate the inclusion of new countries into the uranium-producing group.

1. Introduction

The study of the beneficiation of uranium ores in Spain began in 1948, 2 years prior to the creation of the Nuclear Energy Board (JEN). The scientists and authorities at that time thought that, if Spain wanted to benefit from the energy of nuclear origin, a uranium supply would have to be ensured. During the 1930's, radium had been extracted from Spanish uranium deposits. This appeared to indicate the presence of our own uranium-bearing reserves, and to warrant an effort to make use of them. Four areas of work were established: exploration, beneficiation, analytical chemistry and nuclear physics.

The branch for beneficiation or processing was promptly set up in a Materials Division, which remained with the passage of time. Its mission was the development of suitable processes for the beneficiation of uranium (and thorium) ores, as well as of specific equipment and designs for the necessary plants and industrial facilities. It was also assigned the study of other nuclear materials (graphite and heavy water). Throughout the years, it also concerned itself with other activities (reprocessing, treatment and conditioning of radioactive waste, etc.), which gave rise to other divisions in JEN. Furthermore, it also set up a store of technological information which was transferred to the Spanish non-nuclear industry, in the fields of fertilizers, inorganic chemistry, extractive metallurgy and environmental protection.

JEN also engaged in uranium production (mining and beneficiation) activities, which it transferred during recent years (1973 and 1981) to the National Uranium Enterprise, Inc (ENUSA).

Generally speaking, the research and development in this field originated with a specific problem that had to be solved. The programing was based on the establishment of a direct hypothesis for the solution thereof. Then came the experimental substantiation or modification of the hypothesis. In previous feasibility studies, it was attempted to determine the phases of greatest significance, either because of the conditioning of the process or because of its repercussions on results and/or costs. The greatest attention was given to them. Subsequently, in the experimental development, an attempt was made to optimize conditions and to establish their environments for variation. This development also indicated the areas in which more work was feasible, as well as the paths toward innovation and new development.

In all the studies, the industrial plant that would exploit the results was always borne in mind. The design, and putting into service and operation of the industrial plants, as well as the technical assistance for them, have been an inestimable source of information for planning further development. The cooperation with related groups (mineralogy, analytical chemistry, etc.) facilitated the development.

During the past 30 years, this work philosophy has led:

a. To the development, design, opening (1959) and operation of the Andujar plant, which was operating until July 1981. (Figure 1).

b. To the development and design for the Saelices el Chico plant, opened in 1975. (Figure 2).

c. The same for the La Haba plant, opened in 1978. (Figure 3).

d. To the design and construction (1961) of a plant for concentrate refining.

e. To the development, design, construction and operation (1963-73) of fluid bed plants for UO_3, UO_2 and UF_4 of nuclear purity.

f. To the development and design that is under way for the new Quercus de Saelices el Chico plant (3,000 t/d).

g. To the development and construction of two modular plants for uranium extraction with solvents.

h. To the development and design of two plants for recovering uranium from phosphoric acid.

i. To the design and installation of a plant for recovering indium through extraction with solvents, opened in 1981.

j. To the development and design of a plant, now under construction, for recovering gold and silver from "gossans."

k. To the exporting of technology for recovery of uranium from its ores.

l. To the design, installation and operation of several pilot plants (JEN-CNEN [National Nuclear Energy Commission], 1956; Caridad, 1960; La Carretona, 1963; SX-Fua, 1966; ELE-CR, 1969; LOBO-E, 1970; La Gaviota, 1973; FBC-Lignites, 1978; etc.) which have contributed technological assets to JEN, while simultaneously allowing for the development of the aforementioned projects.

m. To the development and accumulation of a store of technological information available for exploitation.

The current system in this area in Spain consists of:

i. Research and development groups (in JEN and outside of it) for the development of processes which normally reach the "Black Book."

ii. Engineering associations which continue with the project; and,

iii. Commercial associations engaged in production.

The human potential of ENUSA and JEN engaged in this area consists of 370 persons, 37 of whom are higher-level technicians (1).

As of the end of 1981, the production of uranium concentrates in Spain was 1,650 t U_3O_8/yr; while the projects under development for exploitation to begin in 1984-86 represent about 1,200 t U_3O_8/yr.

In the remainder of the report, mention is made of:

The Spanish ores as subjects for the technology;

Certain typical examples of the Spanish experience;

The challenge confronting us at present; and,

By way of conclusion, some comments regarding the approach to this activity in countries with limited means which are embarking on it now.

2. Spanish Uranium Reserves

According to the latest edition of the Red Book (2), the official inventory of Spanish uranium reserves amounts to:

a. 12,450 t U of Reasonably Assured Reserves (RRA), in the cost interval of under 80$/kg U.

b. 3,900 t U of RRA in the cost interval of 80-130$/kg U; and,

c. 8,500 t U of Estimated Additional Reserves (RAE) in the cost interval of under 80$/kg U.

Table I is an unofficial list of reserves made from the standpoint of types of deposits and metallurgical treatment. At the present time, over 63 percent of the Spanish Class RRA-1 reserves belong to the dissemination (or enrichment) deposits in pre-Cambrian metasediments. They are the only ones under exploitation at present (3), and they will also be the supply for the new plants. Moreover, there are good prospects for exploration in this type of formation. The uranium ore is conventional, based essentially on pitchblende and coffinite, but there are oxidized areas in which part of the uranium (15 percent) is located in the limonites and is inaccessible to the acid unless the ore is subjected to roasting at low temperature (4).

A great effort at exploration has been expended in the sandstone type deposits, but the results (21 percent of the reserves) have not been commensurate with it. Nevertheless, it is an area in which work is being continued. We have studied the beneficiation of this type (5) with various alternative diagrams, and it will be possible to proceed to its exploitation when the demand so requires.

The deposits in lodes have been exploited for several years (6), but the majority of them are small, and many are depleted. However, it should be noted that the radioactive indexes in them are very numerous.

The radioactive carbons or lignites are a high-cost reserve the treatment of which is difficult; and hence they are not yet officially included in the Spanish inventory. Our main research activity at present is concentrated on them (7, 8). The goal is to obtain a process that will recover the uranium and the energy content from the organic material. In addition, we are attempting to eliminate the environmental impact that would result from their high sulfur content.

The Sierra Morena paleozoic quartzites could be an enormous reserve of uranium (100,000 t U_3O_8) and other metals (thorium, zirconium and titanium). Their beneficiation was studied in 1964-66 (9), but the prospects were poor. We have recently returned to them in order to confirm the nature and quantity of the reserves, as well as to develop the metallurgical process that will lead to the total utilization of the metals contained therein.

The capacity for phosphoric acid production in Spain is 500,000 t P_2O_5/yr. Each year, over 200 tons of uranium are solubilized in it. JEN studied the recovery of this uranium in 1969 and during the 1970's (10). At present (11), the design of the first plant in southwestern Spain (Huelva) is under way.

The copper water from the old Rio Tinto mines contains uranium (6-10 ppm). The copper in this water is recovered through cementation. In the early 1970's JEN took an extensive sampling from the different mines, and studied the recovery of their uranium through ion exchange. The project was promising, although it did not continue as far as the industrial phase.

3. Conventional Diagrams

Most of the Spanish ores are susceptible to acid treatment. The alkaline process has been applied to a simple uranium ore (12) and to a polymetallic ore of uranium, vanadium and copper with carbonates (13).

The first Spanish plant (Andujar) (Figure 4) (14) adopted a conventional circuit of: crushing, wet grinding, neutral thickening and acid leaching. The solid-liquid separation is done in a dual circuit of thickeners and cyclones. The fertile solution was clarified and treated through ion exchange in a fixed bed (FIX) to recover the uranium. In 1970, this facility was replaced by one for extraction with amines (SX) in JEN-designed settler-mixers.

The uranium concentrate from FIX eluides was obtained through neutralization in two phases, to obtain sodium uranate. In the case of extraction, the aqueous extracts are neutralized with aqueous ammonia in one phase, to obtain ammonium diuranate. The effluents are neutralized with milk of lime, and the radium is fixed through the addition of barium chloride and coprecipitation. One unusual feature is the roasting of limonitic ores in a rotary furnace.It has also been equipped for the treatment of dual ores of uranium and copper (15).

The plant's capacity is 220 t/d of ore, and about 80-90 t U_3O_8/yr. The output is in excess of 90 percent, and the concentrates, with 80-84 percent U_3O_3, lie within commercial specifications. The direct costs (mining and treatment) are less than 30$/lb U_3O_8; and the processing's share of these costs is high (62 percent), because this is a small plant. The largest portion of the plant's costs were for labor (55 percent), followed by that of reagents (21 percent) and fuel (5 percent).

Another plant with acid circuits currently under development is the Quercus project, for 3,000 t/d of ore and 800 t U_3O_8/yr (16). The diagram is a conventional one, with acid leaching, countercurrent decantation and extraction with solvents. One unusual feature is the low acidity attack (pH 1.8-2.0) in the presence of iron, 3 kg Fe^{3+}/m^3, (17) to avoid the consumption of acid by a highly reactive rock.

Mention should also be made of the high degree of recycling (60-70 percent) of effluents of extraction with solvents in the countercurrent washing, and the recovery of the iron from the effluents to be recirculated for leaching.

4. Circuits With Static Leaching

The loss of uranium through water, from stored ores or quarries, has been a concern in Spain (18). So was the utilization of small isolated mines, or low-grade fragments. All of these could be related, through a common operation, such as static leaching. This led to the construction of pilot static leaching plants in four different mines: La Carretona, Caridad, Lobo-E and Fe. The uranium recovery from the liquids was carried out by calcium precipitation in some, ion exchange in a fixed bed in others, and extraction with solvents in still others. At present, there are two industrial facilities operating on this basis. In addition, some modular plants (19) for combined static leaching-extraction with solvents have been developed, with a production capacity of 50 t U_3O_8/yr, and suitable for small mines; because the equipment can be retrieved at the end of the operation.

The largest contribution (165 t U_3O_8/yr) to Spanish production at present is being made by the ENUSA Elefante Plant, in Saelices el Chico (20). The diagram consists of grinding in a single phase up to 100 percent lower than 150 mm. The crushed ore is placed in working areas the base of which has been waterproofed with polyethylene sheeting. Later, it is sprayed with an acid solution (4-10 g H_2SO_4/l), comprised of effluents from extraction (60 percent), new water and acid. The recyclying of extraction tailings contributes iron (4-8 Fe^{3+}/l), which fosters the leaching. The bacterial action (21) present in the ore also fosters the dissolution of the uranium, and causes all the dissolved iron to emerge in ferric form. The leaching output is 80 percent. A marginal portion ($\sim$400 ppm U_3O_8) is leached separately, with a lower result, 48-55 percent uranium solubilization.

The leaching effluents (pH 1.8-2.2) are adjusted in acidity (3-4 g H_2SO_4/l) and, without clarification, are fed to extraction. The extraction is done with tertiary amines and settler-mixers (Figure 5). The reextraction is carried out with NaCl (1 M) in an acid medium (0.05 M); the extracts have from 25 to 30 g U_3O_8/l. The uranium concentrate is precipitated from them with air-ammonia; the temperature here is 30-33° C, a compromise so as to have acceptable grades and good physical characteristics. The concentrate is washed in two decanters, is filtered and is dried at 250-300° C. The final product has grades of 86 percent U_3O_8, 2 percent SO_4, 0.8 percent Fe and 0.3 percent Cl.

The sterile ore solids are left on the waterproofed area itself. On occasion, new foundations are built on them, which only separate them with new waterproofed sheeting. Recently, the oldest working areas have begun to be covered with clay and topsoil. The sterile liquids from extraction which are not recycled are neutralized with milk of lime, and are stored in dikes, in which the red plaster cake decants. The radium from the liquids is coprecipitated with $BaCl_2$. The clear and controlled liquids return to the river on the condition that they cannot increase their activity by more than 1 pCi/l, nor exceed the amount of 5 Ci/yr.

The exploitation of the quarry is contracted; there are 34 persons involved in it. The plant personnel numbers 33. There is a total of 175 persons in the mining center, but most of them are affiliated with exploration. They devote considerable attention to controlling the environmental impact. The direct production cost is under 30$/lb U_3O_8. The mine (under expansion) contributes 58 percent to it, the plant 34 percent and safety and environmental impact control 8 percent.

Another plant using static leaching is the La Haba one (Figure 6) (22). It has a complex circuit, because after the crushing there is a separation of fines and coarse portions. The latter go to static leaching. The fines are attacked in an acid circuit with agitation. The mass is washed in cyclones and the uranium in the mass of tailings is recovered through mass ion exchange (RIP), by means of an automatic slow-screen circuit of JEN design. The sulfuric eluides are combined with the static leaching liquids and are treated with amines by extraction. The uranium is precipitated from the extract with air-ammonia, in a manner similar to that taking place at the Elefante plant. The acid effluents and the masses are neutralized with lime and are stored in a dike, without a spillway to the outside. The liquids are evaporated in it. The plant is small (200 t/d) and it is an intermediate step toward another larger one which will treat the ore from the area which is so altered.

5. Recovery of Uranium From Phosphoric Acid

It has already been noted that, in Spain, about 200 t U_3O_8/yr are solubilized in the phosphoric acid produced. JEN studied this area and developed (23) a recovery process which operated in a pilot plant during 1973-75, with acid just produced at the phosphoric plant. The process (Figure 7) consists of conditioning of the phosphoric acid (cooling and clarification), recovery of uranium through extraction with the synergistic mixture of D2EHPA-TOPO, and reducer reextraction to obtain an extract with 10-12 g U_3O_8/l, which represents only 1-1.2 percent of the original phosphoric acid. This extract is oxidized,and extracted again with the same mixture, but more diluted; and the organic phase is washed and the uranium concentrate obtained by precipitator reextraction. Once filtered, it is roasted at 450° C, obtaining a concentrate with over 95 percent U_3O_8 and very few impurities.

At present, two projects are being developed for 300,000 and 400,000 t P_2O_5/yr. One of them is for a Spanish producer, and the other for the foreign one. The investment for a plant producing 120-150 t U_3O_8/yr is about $20 million; and the direct manufacturing costs are under 20$/lb U_3O_8.

6. Refining of Concentrates and Products of Nuclear Purity

The procurement of products of nuclear purity has been a concern of JEN since its founding. At first, it followed the system of purification with ether (24), but in the mid-1950's it changed to the safer method using tributyl phosphate (TBP) (25). During the 1960's, the line was completed until nuclearly pure tetrafluoride was obtained on a semi-commercial scale, by means of fluidized beds (26), which produced over 100 t UF_4 for metal uranium. This line of work is currently in reserve, although it is in an operational state.

The production capacity (t U_3O_8/d) of the different sections is: refining with TBP, one; UO_3 production by denitrification, 0.85; UO_2 production by reduction with cracked NH_3, 0.56; and UF_4 production by hydrofluorination, 0.37.

Finally, there was a fourth furnace for producing hexafluoride. It progressed satisfactorily, and the only major problem was the electrolytic cell for fluorine generation. Another fluidized bed furnace which is also in this development program is one for the reduction of hexafluoride and hydrolysis with water to produce UO_2 in a single phase (27).

Concurrent research on the preparation of uranium tetrafluoride has followed the wet method. The electrolytic reduction was studied in order to procure from the ore treatment plants products which were more advanced in the cycle than the uranates and uranium oxides. The results (28-29) were very promising, but this line was stopped owing to lack of commercial acceptance for the green cake (UF_4).

Current Challenge

Apart from the exploitation of the technology that has been developed, JEN is now faced with technological challenges for its immediate application, or its application in the near or distant future. The four most important areas are:

a. Uraniferous carbons. Mention has already been made of the case of the Calaf uraniferous lignites, which represent a uranium volume of 40,000 t U_3O_8. In addition to this basin, there are others which could represent over 60,000 t U_3O_8. All of them have some features in common: low grades, 150-400 ppm U_3O_8; high ash content, 30-40 percent; calorific power, 2,500-4,000 kcal/kg; and sulfur, 8-12 percent S. The goals of the research are aimed at: Combustion at controlled temperature ($\sim$800° C) to make use of the energy equivalent and not to insolubilize the uranium. To fix the sulfur, so as to avoid the environmental impact and to dissolve the uranium in the ashes so as to recover the uranium in them. The line in which we are doing the most work (8) is that of combustion in fluidized beds (Figure 8). There are features difficult to arrange, such as the residual limestone in the combustion products and the acid leaching thereof.

b. Paleozoic quartzites. They represent an enormous potential of uranium, thorium, zirconium and titanium. They are materials of low grade (80-200 ppm) in radioactive components, and of very appreciable grade in other metals. The difficulties in their treatment are due to their low grade and to the fact that half of the uranium is incorporated into the zircon system. The interest in their beneficiation has increased with the recovery of the other metals (Ti and Zr) in which Spain is totally lacking.

c. Technological development. Without any direct relation to particular ores, work is continuing on: bacterial leaching (30), continuous ion exchange (31) and improvement of the equipment for extraction with solvents (32).

d. Environmental impact. This is an area that we have separated from the foregoing one to underscore its importance. Problems that we have at present relate to the dikes for the accumulated sterile materials at the Andujar plant, the containment of spoils from mines and the modification or development of treatment diagrams so that they may reduce the environmental impact to a minimum.

8. Final Considerations

We have shown a retrospective view of 30 years of ore processing in Spain. However, we would like to add something else, something not subject to such an early historical development. Countries on Spain's level of development which are now becoming incorporated into the fuel cycle may possibly ask the question: What would you do if it were now, and not in 1948, that you were beginning your uranium program?

Obviously, neither the Spanish situation nor the international context is the same as it was in 1948. At present, there is far more technical information available than at that time. Moreover, there is a difficult market situation for the producers. If we disregard this aspect, with its economic and political implications, it might be possible to idealize the starting situation as that of a country with:

A medium level of development, but without too many economic resources;

Potential for uraniferous reserves;

A determination to initiate and carry out a nuclear program;

A current or prospective, interesting metal extraction industry.

First, there would be the exploration program. This requires analytical and mineralogical services, which could also be the embryo for the processing. Moreover, the subsequent phases of research and evaluation should not be confined to supplying a quantity of uranium, but also its quality; in other words, what prospects does it have for recovery? Hence, the geologists and mineralogists engaged in exploration should bear in mind (33) that the uranium which they discover must be recovered; that is to say, the deposit must be destroyed in order to convert it into concentrate. This is a concern in addition to the one relating to the genesis or formation of the deposit.

Perhaps that would be the time to organize a group or team to study the processing. In principle, this could be limited to a mineralogist with experience in a basic metal; although, since the hydrometallurgy of uranium is very rich, he should be qualified to embark on it, to gather the most fundamental technical information, to organize a leaching laboratory and, backed by the analytical group, to further the prospects of feasibility for the processing.

The goal at this time would be to complete the geological information on the deposit with metallurgical expectations based on a minimum of experimentation and a great deal of study and speculation, all of it, moreover, bearing in mind the country's infrastructure. Perhaps this phase would be the time to contact international agencies (for example, IAEA) or the specialized institutions with which the country itself has agreements.

The next phase might be that of starting the group. From a standpoint of economizing on facilities, it could be set up in a center for geological or metallurgical research. Despite the fact that this is not the custom, it has the advantage of a rapid beginning, economizing on resources and easy absorption or reconversion of the group to other types of metallurgy at the end of its existence. During this phase, the metallurgical experimentation will be done, on a laboratory scale, on all the phases of the potential diagram. [illegible] careful consideration must be given to the heterogeneity of the deposit with respect to the processing. With the results, an attempt should be made at a diagram, with its operating conditions and anticipated results. This will be completed with an exercise in costs and implications, and the specification of the phases with the greatest repercussions. The size of the metallurgical group in this phase might be five higher-level technicians and 10 auxiliary ones.

Assuming that the decision has been made to continue up to the industrial plant, there arises the matter of the pilot plant tests. This is warranted only if the problem is new, if problems involving accumulation are anticipated, if personnel must be trained or if the investment and the risk are very great. Sometimes, it suffices to make a partial test circuit in the most troublesome operations. In addition, contacts could be made with the suppliers of equipment (who in any event will require the making of tests if they have to give guarantees), or else it would be possible to have recourse to some organization having a facility in which the problem diagram could be tested. At the end of this phase, either alone or aided by some local engineering entity, they could draw up the manual for the process, with which the developer could contract the project and the plant.

During the phases of design, installation, opening and operation of the plant, it is beneficial to maintain bonds of unity with the group developing the process. The latter provides additional information and enhances, with industrial experience that will make it possible to schedule the future development on the basis of what is feasible in the plant. Part of the development personnel could be incorporated into the production plants.

In the event that several plants are built, to which the group continues to render assistance, there is a period of lesser demand that could be used to advantage for new development and/or the transfer of the uranium technology to other metals. Hence the importance of having the group integrated into a center that is not exclusively devoted to uranium.

It should also be pointed out that the technology for processing uranium ores is so replete, and with such varied features, that it is magnificent training for other phases of the fuel cycle, to which the technicans who began as uranium mineralogists could be transferred.

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Fig 1.– Vista panorámica de la fábrica de Andujar

Figure 1. Panoramic view of the Andujar plant.

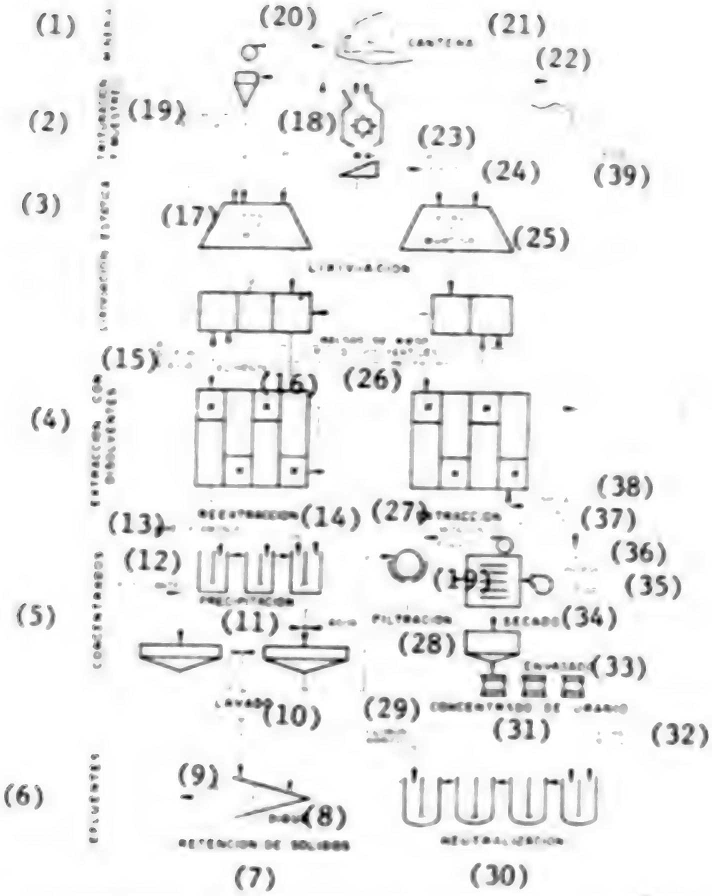


Fig. 2.--Diagrama de flujo de la planta Elefante cerca de Ciudad Rodr

Figure 2. Flow diagram of the Elefante plant near Ciudad Rodrigo.

Key:

1. Mining
2. Crushing and sampling
3. Static leaching
4. Extraction with solvents
5. Concentrates
6. Effluents
7. Retention of solids
8. Dike
9. Water
10. Washing
11. Precipitation
12. Flocculant
13. Air and ammonia
14. Reextraction
15. Sulfuric acid and water
16. Eluent
17. Rich working areas
18. Rich
19. Dust collector
20. Atmosphere
21. Quarry
22. Sterile
23. Marginal
24. Samples
25. Marginal working areas
26. Spraying pools and fertile liquids
27. Extraction
28. Filtration
29. Barium chloride
30. Neutralization
31. Uranium concentrate
32. Milk of lime
33. Packing
34. Drying
35. Air
36. Propane
37. Kerosene alcohol
38. Amine
39. Spoil bank

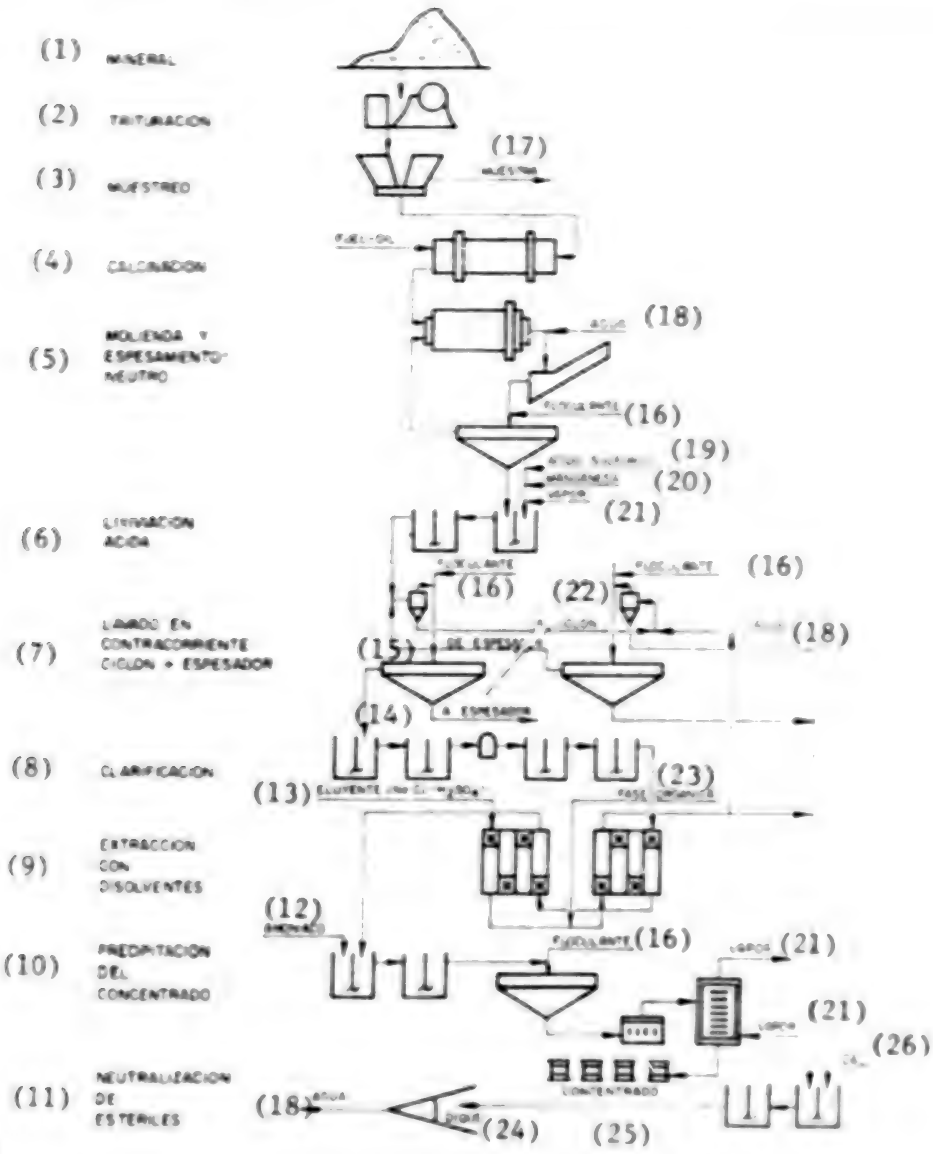


Fig. 4.—Diagrama de flujo de Andujar

Figure 4. Flow diagram of Andujar.

Key:

1. Ore
2. Crushing
3. Sampling
4. Roasting
5. Grinding and neutral thickening
6. Acid leaching
7. Washing in countercurrent, cyclone + thickener
8. Clarification
9. Extraction with solvents
10. Precipitation of the concentrate
11. Neutralization of steriles
12. Ammonia
13. Eluent
14. To thickener
15. From thickener
16. Flocculent
17. Sample
18. Water
19. Sulfuric acid
20. Manganese
21. Steam
22. To cyclone
23. Organic phase
24. Dike
25. Concentrate
26. Lime

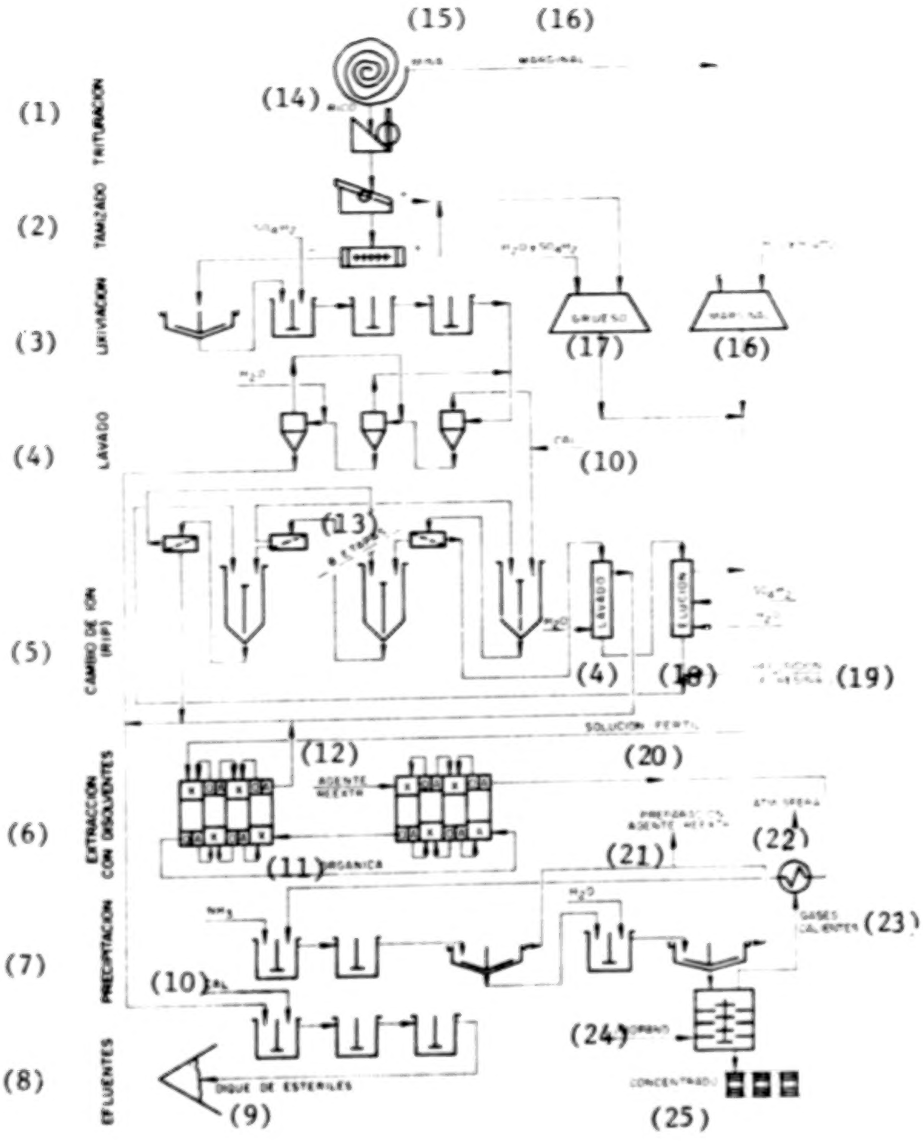
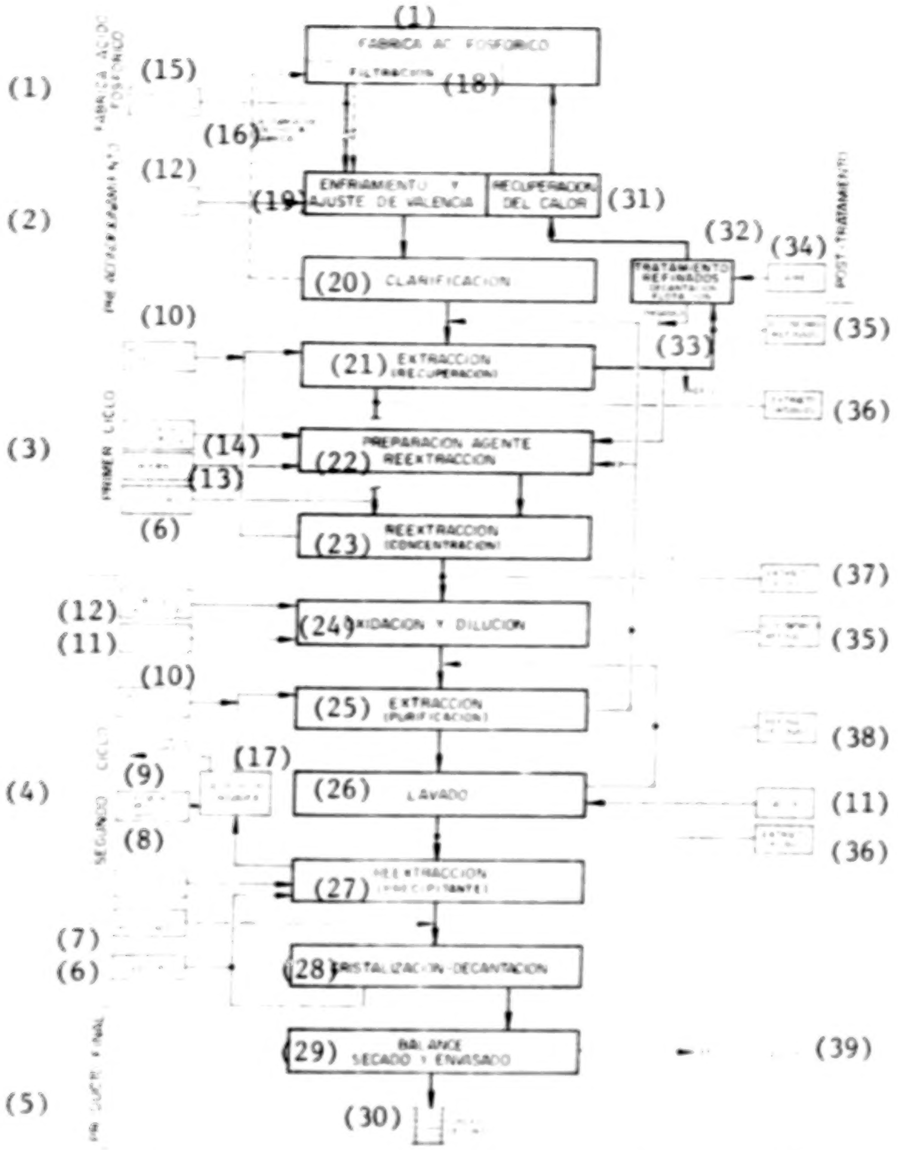


Fig. 6.–Diagrama de flujo de la planta Lobo-G en La Haba.

Figure 6. Flow diagram of the Lobo-G plant in La Haba.

Key:

1. Crushing
2. Screening
3. Leaching
4. Washing
5. Ion exchange (RIP)
6. Extraction with solvents
7. Precipitation
8. Effluents
9. Dike for sterile materials
10. Lime
11. Organic
12. Reestraction agent
13. 8 phases
14. Rich
15. Mine
16. Marginal
17. Coarse
18. Elution
19. Replacement of resin
20. Fertile solution
21. Reextraction agent preparation
22. Atmosphere
23. Hot gases
24. Propane
25. Concentrate


(1)
FABRICA AC. FOSFORICO
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ENFRIAMENTO Y AJUSTE DE VALENCIA
RECUPERACION DEL CALOR
(31)
(32)
(34)
TRATAMIENTO REFINADOS
POST-TRATAMIENTO
(20) CLARIFICACION
(10)
(35)
(33)
(21) EXTRACCION (RECUPERACION)
(36)
(3)
PRIMER CICLO
(14)
(22) PREPARACION AGENTE REEXTRACCION
(13)
(6)
(23) REEXTRACCION (CONCENTRACION)
(37)
(12)
(11)
(24) OXIDACION Y DILUCION
(35)
(10)
(25) EXTRACCION (PURIFICACION)
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SEGUNDO CICLO
(26) LAVADO
(11)
(8)
(36)
(27) REEXTRACCION (PRECIPITANTE)
(7)
(6)
(28) CRISTALIZACION-DECANTACION
(29) BALANCE SECADO Y ENVASADO
(39)
(5)
(30)

Figure 7. Bloc diagram of the JEN process for recovering uranium from phosphoric acid.

Key:

1. Phosphoric acid plant
2. Preconditioning
3. First cycle
4. Second cycle
5. Final product
6. Steam
7. Cooling water
8. Refined phosphoric cond. Ref. Cl
9. To plant with refined
10. Organic replacement
11. Water
12. Oxygenated water
13. Iron
14. Phosphoric acid 52%
15. Acid 28-30%
16. Discharge of solids to plant
17. Organic conditioning
18. Filtration
19. Cooling and valence adjustment
20. Clarification
21. Extraction (recovery)
22. Reextraction agent preparation
23. Reextraction (concentration)
24. Oxidation and dilution
25. Extraction (purification)
26. Washing
27. Reextraction (precipitant)
28. Crystallization-decantation
29. Balance, drying and packing
30. Uranium concentrate

Key (continued):

31. Recovery from heat
32. Treatment of refined materials, decantation, flotation
33. Organic
34. Air
35. Refined phosphoric acid
36. Organic extract
37. Aqueous extract
38. Refining of washed materials
39. Liquid effluents

Table 1.

Spanish Uranium Reserves According to Types of Deposits (ktU)

Type of Deposit	RRA (a)		RAE (a)		
	I	II	I	II	III
Sandstone	3.0	n.e.	n.e.	n.e.	-
Quartz conglomerates	-	-	n.e.	n.e.	-
Disseminations in metasediments	9.0	3.9	8.5	n.e.	-
Intragranitic lodes	0.5	-	-	-	-
Carbons (lignites)	-	40	-	60	-
Paleozoic quartzites	-	-	-	-	102
Phosphoric acid (b)	1.8	-	-	-	-
Copper water	-	-	-	n.e.	-

(a) I, Threshold at 80$/kg U; II, interval at 80 to 130$/kg U; III, lower level at 130$/kg U; n.e. indicates not evaluated.

(b) Uranium contained in 10 years of phosphoric acid production at 1980 capacity.

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